4.

THE ARGUMENT OF SULPHUR OR NO SULPHUR IN WATERS DISCUSSED:

WITH A COMPARISON OF THE

WATERS OF *AIX-LA-CHAPELLE, BATH* AND *BRISTOL:*

WHEREIN

The SULPHUR is reſtored to the two Firſt, and the CONTENTS of the Laſt are aſcertained with a ſomewhat greater degree of Preciſion than in the ESSAY of a late ADEPT; and the injured Credit of divers other ſalutiferous Springs is vindicated, from the EVIDENCE of that Author's own EXPERIMENTS corroborated by many others:

BEING

The Subjects of a Correſpondence between the Author of the METHODICAL SYNOPSIS of MINERAL WATERS, and *W. R.* Eſq; and ſome others.

And to this is ſubjoined

A more explicit ACCOUNT of the NITRE of the ANCIENTS.

To which are annexed, Two TRACTS:

I. The ANALYSIS of MILK, and the ſeveral SPECIES thereof.

By JOHN RUTTY, M. D.

II. A PRACTICAL DISSERTATION on the Uſes of GOAT'S WHEY.

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To the AUTHOR
OF THE
METHODICAL SYNOPSIS of MINERAL WATERS.

SIR,

I Send you ſome Animadverſions furniſhed by cool reflexion upon ſome paſſages in a late Eſſay on Waters, wherein not only you, with moſt of the moderns, but all Antiquity is arraigned for pronouncing any Water ſulphureous.

I commit them to be corrected, digeſted and improved at your diſcretion.

But there is another article beſides Sulphur which alſo calls for ſome notice, and that is Nitre, *which our common Cenſor has endeavoured utterly to explode from waters not leſs than Sulphur; but this I ſhall refer in a particular manner to you, and hope that you alſo in your turn will maintain a ſacred regerd to the maxim of* fas eſt et ab hoſte doceri, *as I have done.*

Yours,

W. R.

THE

PREFACE.

THE deſign of the following treatiſe is not to detract from the real merit of the Author of the Eſſay on Waters, *who having devoted his retirement from his native land to the making of ſeveral uſeful experiments on the mineral waters abroad, has thought fit to offer them to the public, but being pretty much a ſtranger to thoſe nearer home, appears to me to have placed them in an injurious light: neither moreover are the following animadverſions now publiſhed from a peculiar deference to the ſentiments of this author, but as an eſſay to ſettle a point in Hydrology not yet determined,* viz. *whether Sulphur in Subſtance be or be not contained in waters; for beſides* Hoffman, *who is in doubt concerning it, a late eminent French Academician cenſures the writers on theſe ſubjects for confounding Bitumen (in other terms the* Oily Matter) *with Sulphur, and alledges that what is obtained from waters under the denomination of Sulphur, is a creature of the fire in the operation, being the meer reſult of a new combination of Bitumen and the vitriolic Acid; but that Gentleman and the reſt of the compilers of the Memoirs are more excuſable than our Author; for indeed, as far as appears from thoſe Memoirs, they were but little acquainted with the waters called Sulphureous, which are frequent in* G. Britain *and* Ireland, *of which our Author might have informed himſelf from the various experiments and obſervations which had been made on them, ſhewing that thoſe waters, freſh drawn, antecedent to any new combi-*

nation of parts, either by the fire or by putrefaction, but in their natural ſtate, have the ſame effects on the organ of ſmelling and in diſcolouring metals as the Solution of Sulphur, and what is of more importance, in their operation on the human body.

Had I indulged the ſpirit of reſentment, a certain Author might have been here repreſented in a light which would have moved laughter in my readers; but I choſe not to be ludicrous on a ſerious ſubject, and at the ſame time do gladly embrace the preſent opportunity of paying proper regard to every degree of real merit in his performance, and particularly with reſpect to thoſe Experiments of ſome importance confirming the preſence of a volatile ſulphureous Acid, and likewiſe of the Nitre of the Ancients in the Chalybeate waters of Spa, *and in thoſe of* Aken *and* Borſet; *and I have cheerfully ſubmitted to the drudgery of extracting, ſeparating and digeſting theſe and ſome other Experiments from amidſt a* farrago *of extrinſic matters with which they ſtand blended in his book, and of applying them to the elucidation and eſtabliſhment of the point in queſtion, tho' advanced by him with a contrary intention.*

And this may ſerve as an anſwer to the Objection that has frequently been made to the preſent undertaking, viz. *that the Author is not worthy of the ſerious and ſolemn confutation here beſtowed on him; but perhaps it were better that thoſe who made this Objection ſhould abate a little of their pride, and recollect that ſeveral of the Adepts, although bad reaſoners, have left us many valuable Experiments which have proved uſeful to poſterity and been applied to far better purpoſes than the authors of them ever imagined or intended.*

I do alſo moſt cordially acknowledge that the Author's cenſure of the lax and vague ſenſe in which the word Sulphur has been uſed, is undoubtedly juſt, and *may prove a happy occaſion of introducing a greater degree of preciſion in treating on theſe ſubjects, as I humbly hope it has luckily furniſhed the opportunity of the preſent exhibition of the following Experiments and Obſervations tending to eſtabliſh the exiſtence of Sulphur, and of its volatile Acid in waters.*

To conclude, as I apprehend that a blind adherence to the dictates of Antiquity on one hand, and an affectation of novelty and ſpirit of contradiction on the other, are equally enemies to the diſcovery of truth and promotion of ſcience, it will give me great ſatisfaction, if in the judgment of the impartial, I have, in handling this debate, ſteered clear of both theſe extremes.

ERRATA.

In TRACT I.

PAGE 1. to according add to
p. 63. line 6. 7. for volatile read vehicle
p. 84. laſt paragr. for argillareous read argillaceous

In TRACT II:

Line 19. for $0\frac{4}{1}$ read $\frac{1}{4}$

In TRACT III.

To the beginning of the laſt paragr. but one add If
p. 17. for venientie read venienti
p. 21. for Hydadid read Hydatid

THE

ARGUMENT, &c.

SECTION I.

Of the PHLOGISTON, SULPHUR, *and* OILY MATTER, *according Dr.* LUCAS.

THE Phlogiſton he deſcribes to be *a ſimple elementary body, the cauſe of Inflammability, Colours and Odours in bodies; that it is one and the ſame in the ſubjects of the three kingdoms: that Vegetables and Animals abound with it; ſo do Sulphur, Coal and Bitumen, and no Minerals are perfectly exempt from it: that it is the Sulphur of all the medicated Waters of the moderns, or that the principle impregnating the Waters called Sulphureous is Phlogiſton, being wholly diſtinct from Sulphur, and from the Oily matter.*

Thus does this great Reformer of our Language utterly diſcard *Sulphur* from any ſhare in the impregnation of Waters, ſubſtituting the *Phlogiſton* in its Place, and alledging that the *Oily matter* has often been confounded with it; but of how great importance theſe diſtinctions are, and whether his manner of treating them tends to throw light or darkneſs upon the ſubject, may be judged by the following Scheme, exhibiting in one view, the ſcattered accounts given chiefly by himſelf, of the three articles mentioned.

The Phlogiſton.	*Sulphur.*	*The Oily matter.*
1. Has a diſagreeable ſtench (*aa*).	1. Has a diſagreeable ſmell, eſpecially in the ſolution precipitated by acids, (*bb*).	1. Emits a diſagreeable ſtench in putrid waters, like that of a ſolution of ſulphur precipitated by acids (*cc*).
2. Tarniſhes ſilver firſt yellow, then black. (*dd*)	2. The ſolutions of ſulphur tarniſh ſilver firſt yellow, then red, blue, purple and black; and their vapour produces the ſame effects more ſlowly (*ee*).	2. Several putrid waters tinge ſilver of a lead colour, yellow and blackiſh.
3. Gives a black or brown colour to the precipitations of the ſolutions of ſilver or lead, (*ff*).	3. Water impregnated with ſolution of ſulphur precipitates white metals of different ſhades of yellow or brown, according to the ſubtilty of the impregnation (*gg*).	3. Several putrid waters turn yellowiſh and give a browniſh ſediment with ſolution of ſilver (*bb*) and of lead: and ſome river waters give a purple or violet precipitate with ſolution of ſilver (*ii*).
4. Reduces lead to its priſtine metallic form; the whiteſt paint of lead laid upon boards or walls over jakes or ſewers grows black or lead-coloured, and ſoon after puts on a ſhining metallic ſplendor on its ſurface, (*kk*).	4. Sulphur has not this effect.	4. The calx of lead is reduced to its priſtine metallic form by fluxing with any inflamable body, as fat, pitch, or even mineral oil or bitumen, (*ll*).
5. Such waters as contain the Phlogiſton loſe it on being heated, its union to the other principles being lax. (*mm*)	5. Sulphur, when diſſolved in water is decompoſed in the evaporation, the Phlogiſton flying off (*nn*).	5. The Oily matter is ſcarce diſcoverable in any water by the ſenſes before fermentation, putrefaction or evaporation (*oo*).

(*aa*) Eſſay on the waters, Part II. p. 20.

(*dd*) Ibid, Part II. p. 20.

(*ff*) Ibid.

(*kk*) Ibid.

(*mm*) Ib. p. 17 & 21.

(*bb*) Ibid p. 22.

(*ee*) Ib. Part III. p. 35.

(*gg*) Ibid.

(*nn*) Ib. p. 316.

(*cc*) Ib. loc. cit.

(*bb*) Method. ſynop. of min. waters, Book vi.

(*ii*) Eſſay on waters Part I. p. 131. 137.

(*ll*) Ib. Part I. p. 3. 4.

(*oo*) Ib. Part II. p. 22.

1. It does not appear from the foregoing Table that our Author, who uſes great freedom in cenſuring others for confounding theſe three Principles which he pronounces to be ſo widely different, *viz.* *Sulphur*, the *Phlogiſton*, and the *Oily matter*, has yet made any notable advances beyond his predeceſſors, in ſettling their ſeveral proper and diſtinguiſhing characters: For according to him, *Sulphur* agrees to *Phlogiſton* in the Smell, in tarniſhing Silver, in blackening the Precipitations of the ſolutions of Silver and Lead, and in Volatility; in ſhort, in every character except the reduction of the calx of Lead to its priſtine metallic form, and for an obvious reaſon, *viz.* its abounding with a very large proportion of acid to its *Phlogiſton*, whereby it is rather adapted to keep metals in a *corroded* ſtate than to reduce them to a *perfect metallic one:* But his *Oily matter* agrees to the *Phlogiſton* in this laſt mentioned character, and in every other except Volatility, and when volatilized by putrefaction agrees to the other accounts of the *Phlogiſton* in the Table.

The following may ſerve as a Specimen of the ſucceſs of his endeavours to diſtinguiſh the *Oily matter* from the *Phlogiſton:* Part II. p. 21. *Such waters as contain the* Phlogiſton *loſe it on being heated, but the* Oily matter *may be found with the Reſiduum after evaporation of the aqueous humidity.*

A very peremptoty and deciſive account of the matter truly: What pity it is but it were a juſt one? But alas! when we come to apply this rule to facts, as ſhall be done in the ſequel, we find ſeveral undeniable inſtances of the *Phlogiſton* being retained in the *Reſiduum* after the evaporation of the aqueous humidity, and ſo we are left equally bewildered as before; and the decompoſition of *Sulphur* by the flying off of the *Phlogiſton* in evaporation will hereafter be ſhewn to be imaginary.

But, to do him juſtice, it muſt be confeſſed he has taken care elſewhere *(a)* to lay down the diſtinguiſhing Marks of *Sulphur* and its *Hepar*; but it is alſo obſervable that moſt of thoſe marks are actually found in the waters called Sulphureous, or in their natural products, as ſhall be exemplified in the ſequel.

2. The congruous appearances exhibited by the *Sulphur* and *Phlogiſton* in the above Table ſhould ſeem to ſhew their ſimilar nature, except in the greater proportion of acid in the former; but according to our Author, theſe two ſubſtances are wholly diſtinct, and ſo far diſſimilar that the appearances common to *Sulphur* and *Phlogiſton* in the above Table, are not owing to *Sulphur* qua *Sulphur*, but to the diſengaged *Phlogiſton* or inflammable principle alone *(b)*, ſo that the diſcolouring of Silver, and of the Precipitates exhibited by the ſolution of Silver and Lead, which have hitherto been laid down as marks of *Sulphur*, are by him deſtroyed as ſuch and appropriated to the *Phlogiſton*: For (proceeds he) *Before the* Phlogiſton *is ſet at liberty by breaking in ſome ſort its connection with the univerſal acid in* Sulphur, *by the interpoſition of alcali's, lime or other matters that abſorb or overcome the acid*, Sulphur *alone, or the concrete Sulphur, is not found to gild Silver or tinge it yellow; but as ſoon as the connection aforeſaid is broke, and the ſolution of* Sulphur *is made by lime or alcalis, then the diſengaged* Phlogiſton *flies off, ſtrikes the ſenſe of ſmelling with a putrid ſtench, tarniſhes Silver*, &c.

I confeſs I am not without ſuſpicion that an affectation of ſuperior Science, and particularly an exceſſive fondneſs of the greek Word above mentioned pretty much a ſtranger to vulgar ears, may have betrayed our Author into an utter neglect of the

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(a) Eſſay on Waters, Part III. p. 35. *(b)* Ibid. p. 278.

the evidence of common ſenſe: For where is the alcali to let looſe the *Phlogiſton* in an ointment of brimſtone and butter ſo offenſive to delicate ladies in the cure of the itch? And, taking for granted that the diſcolouring of other metals by *Sulphur* proceeds from the ſame principle, as that of Silver, has he forgotten the colour induced to quick-ſilver by *Sulphur* in the *Æthiops mineral* by meer trituration? But not to evade the teſt by Silver, a ſilver tea-ſpoon by a ſingle immerſion into the melted flowers of *Sulphur* receives an almoſt indelible ſtain: And is not all this effected by the concrete *Sulphur*, or *Sulphur* alone? Vain therefore are his endeavours to deſtroy theſe obvious marks of *Sulphur*.

Our Author however proceeds without reſerve or ſubterfuge (not to ſay without caution) to aſſert that *the fetid ſmell and tarniſhing Silver in putrifying Waters* (to which he compares thoſe called ſulphureous) *is owing to the Phlogiſton*, and not only ſo, but *to Phlogiſton alone. (a)*

I ſhall therefore ſhew that the effluvia of putrid Waters do not furniſh an adequate proof of this poſition, becauſe it is certain that they do not conſiſt of *Phlogiſton* alone, but contain alſo a volatile alcaline ſpirit and ſalt, as has been proved by particular Experiments on putrid Sea-Water, and putrid Rain and Spring-Waters, and therefore it does not appear that the above-mentioned Phenomena of fetor and tarniſhing Silver are owing to the *Phlogiſton* alone, but rather to a combination of it with the volatile alcali; and this may be of notable uſe in diſtinguiſhing the great difference between Waters become fetid by putrefaction and the natural ſulphureous Waters, in this important reſpect, that in the firſt the *Phlogiſton* is combined with a volatile alcali, whereas in the laſt it is found to be combined with a volatile acid, as ſhall be ſhewn in the ſequel, and even from ſome of our Author's own experiments.

(a) Ib. p. 279.

In the mean time it would be neceſſary to examine the *Phlogiſton* in a ſtate of ſimplicity, or in ſuch a form where it makes the neareſt approach thereunto, or at leaſt that ſubtile fluid or fluids wherein it is found in greateſt abundance, as far as cognizable to our ſenſes and capable of being ſubjected to experiments, in order to determine how far the fetor and the tarniſhing of Silver in waters is or is not owing to the *Phlogiſton* alone.

In this inquiry we are not to take in every inflammable vapor or ſubtile matter, not even that which conſtitutes the fulminating damp in mines, taking fire at the approach of a candle, for this, according to the deſcription given us of it, *(a)* leaves a ſtrong ſmell of brimſtone; but there is another *Phlogiſton* which approaches much nearer to ſimplicity, being found void of all ſmell, and that is, the ſubtile inflammable vapor which immediately catches fire at the approach of a lighted candle, being found floating on the ſurface of divers waters, and even of ſome earths, and is the genuine production of the Petroleum, and often found in the neighbourhood of Coal-Mines; and the conſideration of this ſpecies of the *Phlogiſton* will be more to the preſent purpoſe becauſe of its affinity to that of *Sulphur*, which is allowed to be compoſed of ſome bituminous matter united to the vitriolic acid.

The following inſtance of one of theſe phlogiſtic vapors has been tranſmitted: " In ſome *Derbyſhire* Lead mines near *Whetſtone-edge*, have been obſerved ſome ſmall drains or rills of clear water trickling down a Lime-ſtone rock: The workmen at night, when leaving off work, for

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(a) Lowthorp Abr. Phil. Tranſact. Vol. II. p. 377.

one or more days, only by holding a candle to this water, ſet it on fire, which continues burning with a blue flame till they return to their work and light their candles at it again, and extinguiſh the ſmall paſcent flame on the water's ſurface. Here was a true *Phlogiſton* without ſmell or damp, and no perceptible acid, which would have effectually ſpoiled the fine rich Lead ore. In the ſame mines was an abundance of pretty large Boulder-ſtones, whoſe ſurface was only a ſhell full of a whitiſh grey ſolid matter, which liquified before the fire, manifeſting itſelf to be a clear Bitumen." And near akin to this is the flame emitted from a certain ſpot of ground on a ſide of the *Appenine* mountains, mentioned in the *Philoſophical Tranſactions (a)*, which is alſo without ſmoak or ſmell.

Here then is a notable ſpecies of *Phlogiſton*, and which makes the neareſt approach to ſimplicity, which is both inflammable and utterly void of ſmell, nor moreover is it eſſential to the waters on the ſurface of which this *Phlogiſton* floats, to tinge Silver: for the burning Well near *Wigan* in *Lancaſhire*, is a ſtrong inſtance to the contrary, the water of which does not tinge Silver, whereas according to our Author's theory, one would imagine that ſuch waters where the *Phlogiſton* was in greateſt abundance ought to have the greateſt effect in tinging Silver, and that theſe phlogiſtic vapors are entirely and ſpecifically different from thoſe of the waters called ſulphureous, appears from hence, that theſe laſt are ever diſtinguiſhed by their fetid ſmell, and are not inflammable at all, which is agreeable to the nature, not of meer *Phlogiſton*, but of *Sulphur*, in which the acid ſo greatly predominates over the *Phlogiſton*: from all which appears the raſhneſs of our Author's poſition,

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(a) Lowthorp, Ib. p. 385.

ſition, that the fetid ſmell and tarniſhing of Silver in Waters is owing not to *Sulphur* qua *Sulphur*, but to the *Phlogiſton* alone.

I ſhall give but one inſtance more, in ſupport of the truth of this concluſion, which, tho' it be of a production of art, and chiefly from a vegetable, yet as the *Phlogiſton* or principle of inflammability is declared to *be one and the ſame in the vegetable, animal and mineral kingdoms*, will ſcarce be deemed impertinent, and that is Æther, being one of the moſt inflammable of all liquids, and which, like the vapor on the waters before mentioned, catches fire at the approach of a lighted candle, being the highly attenuated oil, phlogiſtic or inflammable part of wine, and which in ſeveral appearances exactly reſembles that moſt ſubtile Bitumen called Naphtha.

I procured therefore a ſpecimen of the vitriolic Æther exquſitely pure from Dr. *Francis Hutcheſon*, Profeſſor of Chymiſtry in *Dublin*, and immerſed Silver in it, and expoſed Silver to its vapor, but found that it had no effect in tinging the Silver; neither moreover had it any effect in producing any diſcolourations with the ſolutions of Mercury, as appears in the Table annexed: But when in the ſubſequent part of the proceſs the *Phlogiſton* is ſo far combined with the acid of Vitriol as to conſtitute the volatilized acid called the Gas of Vitriol or *Sulphur*, this has manifeſt effects on Silver and its Solution; and on the ſolution of the cryſtals of Quickſilver, as appears in the ſame Table: So that this affords another inſtance of one of the moſt highly phlogiſtic bodies having no effect in diſcolouring Silver, even not until it makes a nearer approach to *Sulphur* by being combined with a notable proportion of acid.

Upon the whole, it appears from theſe inſtances how arbitrary and deſtitute of ſupport from experiment this novel dicision of our Author is, that the *Phlogiſton* or inflammable principle alone is the cauſe of the fetor and of tarniſhing Silver in *Sulphur* or any waters ſuppoſed to be therewith impregnated.

SECTION II.

Objections againſt the exiſtence of Sulphur *in waters conſidered.*

I. THE firſt Objection is, that altho' they, and particularly the *Aken* waters, agree to a ſulphureous impregnation by their ſmell and ſome other effects, yet they are abſolutely colourleſs, *whereas a much ſmaller portion of actual* Sulphur *than appears to be in theſe waters would give a ſenſible yellow colour to a much larger quantity of water (a).*

Anſw. This unphiloſophical objection, whilſt it ſhews an utter inattention to the extreme diviſibility of matter, proceeds upon a ſuppoſition that the ſolutions in the pitiful proceſſes made in our elaboratories are as perfect as thoſe of nature, which is far from being the caſe; on the contrary, the minerals taken up into waters in nature's workmanſhip, are in a moſt incredibly attenuated ſtate, and to this extremely ſubtile ſtate of the diſſolved minerals, do we juſtly impute their ſuperior energy and activity in waters: and this is apparently the caſe, particularly in the Sulphureous, whoſe vapors diffuſed many yards round affect the noſe, and ſometimes metals in the pockets of thoſe that are near them.

But were I inclined to condeſcend to the dull and groſs conceptions of our Author in theſe matters, as if Colour were an eſſential mark of *Sulphur* in waters, I could ſwell my book with an account of

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(a) Eſſay on waters, Part III. p. 69.

of the various operations of nature in this reſpect by enumerating great numbers of waters of this ſort which are as colourleſs as thoſe of *Aken*, whilſt others are of a bluiſh caſt, or of a reddiſh brown, and ſome of a milky colour, particularly the *Aqua Zolfa* found on the road from *Rome* to *Naples*, mentioned in the Memoirs of the French Acadamy, *A. D.* 1750, but I rather haſten to a more direct anſwer to his declaration that a *much ſmaller (a) portion of* Sulphur *than appears to be in theſe waters—by any known means of art diſſolved in them, would give a ſenſible yellow colour*, by informing him that an artificial ſulphureous water was lately preſented to a certain medical Society in *Dublin* by that ingenious Apothecary *Henry Barton*, author of the *new method of the improvement of the manufacture of Drugs*, being a ſolution of *Sulphur* which had all the marks of the natural ſulphureous waters, and from which I myſelf precipitated a Lac by ſpirit of Vitriol, and yet was as tranſparent as common water, the method of preparing which, together with ſome other uſeful matters the Author intends to divulge at a proper ſeaſon: in the mean time I endeavoured to imitate the above by a leſs ſaturated ſolution of *Hepar Sulphuris* in the proportion of 21 grains to a quart of ſoft water, which was ſo diluted that it ſtill retained its tranſparency, and agreed to the natural ſulphureous waters in the flavour, and particularly in the fetid ſmell, upon adding Spirit of Vitriol, in order to precipitate the *Sulphur*, tho' there appeared only a ſubtile white cloud ſuſpended in the upper part of the glaſs, (even as in divers of the natural purer ſulphureous waters, agreeable to the ſubtilty of their impregnation;) and moreover it tinged Silver and its ſolution in the ſame manner as the natural ſulphur-waters do.

(*a*) Eſſay on Waters, Part III. p. 69.

Objection II.

OUR Author lays it down as an *eſtabliſhed axiom*, (*a*) *that* Sulphur *is not by itſelf ſoluble in water, and can be diſſolved by no other means known than thoſe of alcaline ſalts or earths:* and that, if *Aken waters (b) were ſuch a ſolution of* Sulphur *as to contain actual and ſubſtantial* Sulphur, *an Alcali muſt be predominant in them.——whereas a volatile acid is evidently contained in them, and all the mineral acids, inſtead of cauſing any precipitation, as they muſt do in all ſolutions of* Sulphur, *increaſe and preſerve the pellucidity of theſe waters.*

Anſw. The whole force of this Objection reſts on a ſuppoſition no leſs preſumptuous than this, that for as much as our Author knows no other method of impregnating *Sulphur* with water, that therefore Nature itſelf has no other method of effecting this. It is therefore neceſſary to inform him that not only Nature, but even Art can diſſolve *Sulphur* in water by other means than a meer Alcali: for, in the Experiment to be related in the next ſection it will appear that *Sulphur* may be divided into ſuch minute particles by meer mechanical attenuation, as to be kept inviſibly ſuſpended in water, for a conſiderable time, and afterwards precipitated from it; and if the feeble art of man can effect this, the argument is ſtrong that the power of Nature is not reſtricted to alcaline ſalts as the ſole medium by which *Sulphur* is ſoluble in water.

It were but juſtice indeed to allow thus much in favour of this Objection, that the native Alcali is a very frequent ingredient of the waters called *Sulphureous*; but to infer from thence that Nature is to be confined within theſe narrow limits were very raſh, and contrary to what is found to be the

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(*a*) Eſſay on Waters, Part I. p 99. (*b*) Ib. Part III. p. 70.

caſe in ſome of the ſtrongeſt of theſe waters, particularly that of *Harrigate* in *Yorkſhire* and the *Aquæ Badenſes* in *Germany*, both which are impregnated not with an alcaline, but marine ſalt, in a notable quantity, and conſequently ſome other menſtruum than an Alcali muſt be admitted for diſſolving the *Sulphur* with which both theſe waters are eminently impregnated.

If then Nature has other methods of impregnating with *Sulphur* than a meer Alcali, the force of the Objection from the want of a precipitation by Acids entirely vaniſhes: nevertheleſs ſince the *Aken* waters in particular, which are allowed to contain the native Alcali, are ſpecified as a ſtrong inſtance of this want of precipitation by Acids, I ſhall here minutely conſider it, as it will give opportunity of making ſome obſervations tending to clear up this matter.

We are aſſured then, as above, that *the mineral Acids, inſtead of cauſing any precipitation in Aken waters, are found to increaſe and preſerve their pellucidity.*

Perhaps there had been more candor in this Objection if, inſtead of aſſerting this of mineral Acids only, it had been aſſerted that Acids in general cauſe no precipitation; but the objector ſeems to be well aware that this would have not agreed to a ſubſequent experiment of his on a certain vegetable Acid, and therefore it was requiſite he ſhould confine his objection to the mineral Acids only; for we find in the courſe of his experiments on theſe waters that diſtilled Vinegar (*a*) produces a *milky hue or milkyneſs* with them, even with the water freſh from the ſources and with the cold water, but not with the evaporated, and this he imputes to the *Phlogiſton* preſent in the freſh and in the cold water, but not in the evaporated. It

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(*a*) Eſſay on Waters, Part III. p. 89, 90.

It is probable other leſs accurate chymiſts might call this milkyneſs an incipient precipitation or Lac of *Sulphur*, and the rather becauſe it is well known that it is not peculiar to the mineral acids to precipitate *Sulphur* from its ſolution, but that Vinegar and other diluted Acids do alſo effect the ſame thing: but it will ſtill be urged, Why do the mineral Acids exhibit no appearance of a precipitation? I anſwer 1ſt, by reaſon of the extreme ſubtilty and volatility of the *Sulphur*, and 2dly, perhaps by increaſing the pellucidity of this water on another account, even by effecting a more intimate ſolution of the terreſtrial matter contained in theſe waters, whereby they become more tranſparent, this being an ordinary effect of the mineral waters on this account: Perhaps this experiment with the mineral Acids on *Aken* waters may deſerve to be reiterated with a little more attention: however, be the caſe of *Aken* waters what it will, it appears from the teſtimony of others concurring with my own obſervations, that the mineral Acids have a very different effect upon ſeveral of the waters called *Sulphureous* than what they have upon thoſe of *Aken* according to our Author, and which waters are more ſimply *ſulphureous* than thoſe of *Aken*, even that they are ſo far from increaſing their pellucidity, that upon a minute and careful obſervation they are found to exhibit a milky cloud on being dropt into ſeveral of theſe waters, particularly thoſe of *Moffat* in *Scotland*, which, when freſh always turned milky with Spirit and Oil of Vitriol and Spirit of Nitre; and the ſame appearance is alſo exhibited by the mineral acids added to the *fons Wirſingavenſis* in *Sileſia*, and ours of *Swadlingbar*, *Killaſher* and *Lucan* near *Dublin*.

But, to return, as our Author by his repeated, peremptory declarations, that *Sulphur* cannot be actually or ſubſtantially diſſolved in water without the intervention of an alcali, would ſeem to take upon him to reſtrict the powers both of nature and art within the narrow bounds of his own ſcanty conceptions, I ſhall here ſhew that he is far from having ſounded the depths of the art in which he would ſeem to diſtinguiſh himſelf, by giving a clear and undeniable inſtance, in a ſhort chemical proceſs, of *Sulphur* being ſo far attenuated as to be diſſolved or kept inviſibly ſuſpended in water for a conſiderable time without the leaſt aſſiſtance of an Alcali.

This experiment was communicated by a worthy brother of the profeſſion, as having been firſt made by *Chrouet* in a treatiſe *de Aquis Aquis granenſibus*, publiſhed in 1713, *viz.* He took two iron retorts into one of which he put four drams of *Sulphur*, into the other three pints of water, and inſerting the neck of each retort into a hole at each end of an empty barrel, and placing each retort on the fire at the ſame time, the ſteams uniting in the barrel, and afterwards condenſed, formed a liquor reſembling the waters of *Aken*; but he obſerves that if the *Sulphur* be waſhed from its acidity, the experiment does not ſucceed.

This experiment ſeemed to be well worthy of being repeated, which accordingly was done, as follows, by Dr. *Francis Hutcheſon*, Profeſſor of Chymiſtry in *Dublin*, with ſome little variation, and withall ſome further experiments on the product of the operation: he uſed glaſs retorts inſtead of iron ones, and flowers of *Sulphur* and pump water, and the ſteams ariſing from each of theſe being united and condenſed in an empty barrel perforated as above, exhibited a clear water, not indeed of the ſmell of *hepâr ſulphuris* (nor reſembling the *Aken* Waters as *Chrouet* affirms) but rather of the volatile Acid of *Sulphur*: however, that a real *Sulphur* was inviſibly ſuſpended in this water, appeared from the following experiments: it had the like effect, not only on the ſolutions of Silver and of other metals, but on Silver in ſubſtance, (even by immerſion in the liquor and by the vapor) that the ordinary ſolution of *Sulphur* has, as appears in the Table hereafter annexed, particularly in tinging Silver of a dark leaden colour, which is more than the volatile Acid of *Sulphur* does: to which add, that the precipitates formed in this water by the addition of mercurial ſolutions, being both ſeparately dried and thrown on the red hot iron, ſhewed pure *Sulphur* by the blue flame and ſuffocating ſmell: indeed the ſolution of ſugar of Lead gave only a white cloud and a white grumous ſediment, with a few black ſpots at the bottom, an appearance perfectly analogous to what is effected by the mixture of *Bath* waters and that ſolution; but what puts this matter out of all doubt is, that this water left at reſt three or four days, depoſites a real *flos ſulphuris* manifeſted by its appearances on the fire, and every other characteriſtic of *Sulphur*.

Objection III.

OUR Author however, acquainted with no other means of diſſolving *Sulphur* but an Alcali, proceeds upon a ſuppoſition of its being ſo diſſolved in water, to ſhew that it would be impoſſible to demonſtrate it, for this reaſon, that *as ſoon as the* union of the acid and *Phlogiſton* in the *Sulphur* is broken, and *a ſolution of* Sulphur *is made by Lime or Alcali's, the* Phlogiſton *flies off, whilſt the acid baſis of the* Sulphur *unites with and ſaturates the alcaline ſalt by whoſe means it was diſſolved* (a): *and that here is a perfect decompoſition of* Sulphur, *is evident from this, that without adding an Acid, ſuch a ſolution cannot be revived into* Sulphur, *whereas, by reſtoring what the Alcali deſtroyed, an Acid, all ſuch ſolutions yield a precipitate of* Sulphur.

(a) Eſſay on Waters, Part III. p. 279, 280, 316.

To this it is anſwered, that the Decompoſition here aſſerted, and the entire flying off of the *Phlogiſton* is altogether imaginary and unchemical: for 1ſt, if the *Phlogiſton* were really, as our Author ſays, *totally diſengaged from the acid*, whilſt this united itſelf *with and ſaturated the alcaline ſalt*, Sulphur could not be reproduced without recalling or introducing new *Phlogiſton*, which is contrary to daily experience in making Lac ſulphuris, where the meer addition of an acid throws down the *Sulphur* in the white magiſtery of that denomination, which is á perfect *Sulphur* in inflammability and every other character. 2dly, The ſuppoſition of the *Phlogiſton* quitting its ŏwn acid and leaving this to unite itſelf with the alcaline ſalt is directly contrary to the doctrine of the affinities of bodies, even as reported by himſelf, Part I. p. 11. of his Eſſay, where we find that the attraction between the inflammable principle and the vitriolic (or ſulphureous) acid is the ſtrongeſt of all, and ſpecified as ſuperior to that between the ſame acid and fixed alcali's; and that it really is ſo appears from the production of *Sulphur* by the decompoſition of *Tartar vitriolatum* and other neutral ſalts by fuſing them with Charcoal, where the vitriolic acid having a ſtronger affinity with the *Phlogiſton* in the charcoal, quits the alcali and uniting itſelf to the *Phlogiſton* forms *Sulphur*. See *Macquers Elemens de Chymie pratique*, Sect I. Chap. 1. And 3dly, poſitive experiment on the ſolution of *Sulphur* made in Lime water is againſt him: for this ſolution being evaporated, left behind it a real *Sulphur:* but to come to real facts in relation to the waters called ſulphureous, it will appear that the union of the acid and *Phlogiſton* in thoſe waters is far from being ſo lax as he ſuppoſes, and from a partial examination of a few of them haſtily aſſerts. I will readily grant him that the *Phlogiſton* is extremely volatile in the weaker and lighter waters of this claſs; but that this is the caſe in the ſtrongeſt ſort I deny: for, beſide the *Harrigate* water, *(a)* which retains its ſmell even when a phial of it has been kept in a pan of boiling water a long time, the water of *Drumaſnave* in *Ireland* retains its ſmell when evaporated to the conſumption of half: but ſtill much more ſtrong and clear is our Author's own poſitive teſtimony, ſhewing that the *Sulphur* in waters is neither decompoſed nor loſt upon evaporation, but depoſited and ſtill abides, even in the ſtate of a fixed acid and *Phlogiſton*, (the genuine and component parts of *Sulphur)* cloſely united, reſiſting the action of the ſun, air and winds, nor ſeparable but by the action of the fire: for he tells us *(b)* of the lower ſprings of *Borſet*, that *wherever they touch the wood in their current, or ouze from the ſoil, theſe places are covered over with a white, ſoft, ſilky hoar, which being dried and thrown upon an ignited iron, catches fire, emits a blue flame and an intolerable acid vapor, being no other than one of the Conferva's, incruſted,* (in his own words) *with ſome particles of fine, ſubtile Sulphur.* Such is the glaring evidence of Truth that it will out, even from the mouth of an adverſary in ſome of his unguarded moments; and that this really is the truth will be confirmed in the ſequel by a minute examination of the like white Cruſt depoſited by other waters of this denomination.

Objection IV.

THE fourth Objection is, that no argument can be drawn of the preſence of *Sulphur* in any waters from their effect in diſcolouring Silver, becauſe this is an effect common to bilge water and other putrified waters, to the excrements

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(a) Short's Hiſt. of mineral waters, Vol I. *(b)* Eſſay on Waters, Part III. p. 189.

of animals, jakes and ſewers in cities, to ſtale urine, and to the yolk of an egg boiled or roaſted hard, which are not to be deemed ſulphureous from this circumſtance alone, or bear no relation to *Sulphur:* *(a)* and elſewhere *(b)* ſpeaking of one of the ſtrongeſt of theſe waters, he challenges us to prove by a ſingle experiment that it is more ſulphureous than putrid ſea-water, or any of the other ſalt ſprings that putrify on ſtagnation.

Anſw. This is a high ſcandal upon the waters we call ſulphureous, and if juſtly grounded, ought to terminate in their utter rejection as a medicine, which however are found by experience to have intrinſic merit more than enough to ſupport themſelves under theſe unjuſt reproaches.

I ſhall however give his Objection its due weight, and grant that it is indeed common to putrid waters and to thoſe called ſulphureous to tinge ſilver; but our Author has not vouchſafed to inform us whether they equally agree in other reſpects, whereas upon a careful compariſon it will abundantly appear that the reſpective contents of the waters become fetid by ſtagnation and putrefaction, and the contents of thoſe called ſulphureous, are widely different, and even of oppoſite qualities: for it is an undoubted fact that rain-water, ſea-water and other waters, are ſo far changed by putrefaction that the *ſal medium* naturally contained in them is transformed into a volatile alcaline ſalt, ſo that its well known that they yield an urinous ſalt and an alcaline ſpirit, which is alſo the caſe of putrid urine, *&c.* And on the contrary, it is no leſs certain from undoubted facts, that divers of the waters called ſulphureous are ſo far from yielding a volatile alcali, that they yield a volatile acid: of this we have a ſenſible proof in ſome of the ſulphure-

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(a) Eſſay on Waters, p. 280. *(b)* Analyſis of Rutty's method ſynops. of min. waters.

ous waters in *Italy*, where they are frequent, and their ſmell very offenſive to the paſſengers, particularly on the road from *Rome* to *Naples*, of which we have the following account in the Memoirs of the *French* Academy of the Year 1750. *Elles ſont preſque toujours plus chaudes que l'air de l'atmoſphere, et d'une couleur laiteuſe ſembable a celle de giraſol; la vapeur qui en ſort penetre inſenſiblement les pierres le plus dures qui s'y trouvent expoſees, elle les enduit de fleur de ſoufre, elle les calçine interieurement, et les diſſout de telle ſort qu'elles deviennent legeres et perdent beaucoup de leur conſiſtance naturelle.* And this is ſtrongly corroborated by the analogous effects of the acid vapors of the waters of *Aix-la-chapelle*, *Borſet* and our *Bath* waters, in corroding the iron works near them, as mentioned by our Author; *(a)* and indeed there are very few of the waters called ſulphureous but what ſo far manifeſt an acidity as in ſome degree to coagulate with ſoap and alcali's. This then is one conſiderable article in which the *Phlogiſton* in ſulphureous waters differs from that in putrid waters, that in theſe it is combined with a volatile alcali, in thoſe with a volatile acid, and their operation and effects are alſo very different; and ſo the air impregnated with the effluvia of waters turned putrid by ſtagnation in low fenny countries is always unwholeſome, whilſt the ſteams riſing inceſſantly from ſulphur-waters into the air are ſo far from cauſing or promoting Epidemics that ſuch an air checks and breaks their force by the volatile acid: and how the putrid waters do agree to thoſe called ſulphureous in their lightneſs on the ſtomach, raiſing the ſpirits and other ſalutiferous effects the Author of this calumny on the laſt named waters is called upon to anſwer.

(a) Eſſay on Waters, Part III. p. 64.

But it is needleſs to add any thing further in order to ſhew the groundleſſneſs of the above inſinuation than to appeal to facts in relation to the real ſtate of the waters called ſulphureous, ſeveral of which are ſo far from ſtagnating that they flow with a rapid ſtream, (particularly that of *Cunley-houſe* mentioned by Dr. *Short*, and the *Aqua Zolfa* in *Italy* mentioned in the 50th Vol. of the Memoirs of the Royal Academy) are clear and full of a volatile elaſtic matter, exhibiting perpetual ſtrings of air bubbles, even as do the waters of *Aken*, the ſmell of which is alſo like that of the cold ſulphureous waters; and to this add that it is rare to find true ſulphur-waters in low, boggy, fenny countries; and where waters do ſtagnate and putrify, as in great levels and in deep peat or turf moſſes, their ſmell is very different from that of a true ſulphur-water.

SECTION III.

Poſitive Proofs of Sulphur in waters.

I. THE Smell both of the waters of *Aix-la-Chapelle*, and of the cold waters called ſulphureous in *Great-Britain* and *Ireland*, is exactly the ſame, even like that of a ſolution of *Sulphur* in an alcaline ley, *(a)* or like that of the waſhings of a gun fouled by frequent firings of gun-powder.

II. The effects of *Aix-la-Chapelle* and other waters called ſulphureous, whether hot or cold, and of their vapors in diſcolouring metals and their ſolutions, are the ſame, being like thoſe of a ſolution of *Sulphur* in an alcaline ley, or *Hepar ſulphuris.*

III. Although it is granted that the quantity of *Sulphur* contained is but ſmall, and not eaſily collected

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(a) Eſſay on Waters, Part III. p. 53.

lected pure and diſtinct, being diſguiſed by various mixtures with other minerals, yet divers of theſe waters do yield a real *Sulphur* both in their vapors and in the *reſiduum* left by them: *v. g.* The *Thermæ Badenſes (a)* yield in the upper part of the pipes thro' which the water runs, a ſubſtance ſcarce to be diſtinguiſhed from flowers of *Sulphur*: and the accurate *Walerius* in his *Mineralogie* mentions a native *flos ſulphuris* found ſwimming on the ſurface of ſome waters; to which add the teſtimony of that learned and induſtrious enquirer into theſe ſubjects, *Georgius Agricola*, who in two places *(b)* affirms that *Sulphur* is obtained ſubſiding as a ſediment by decoction from the waters at *Buda* in *Hungary*; but above all, the *Aix* Sulphur is an undeniable inſtance to this purpoſe; but our Author endeavours to evade the evidence from theſe facts of a palpable *Sulphur* thus collected by a certain hypotheſis, the honour of the invention of which it muſt be owned is due to himſelf, which hypotheſis, as it will be minutely conſidered in the Letter annexed to the end of this ſection, I ſhall ſay nothing more of in this place, but proceed to examine ſome of thoſe foreign waters, particularly in *Italy*, which give undoubted evidences of an impregnating *Sulphur* ſupplied by magazines of this mineral in the bowels of the earth, and compare them with thoſe in theſe colder climates, in order effectually to ſilence the clamour againſt them as meer putrid waters. Now it is certain from the deſcriptions that travellers have given us of theſe waters that they agree in all ſenſible appearances to thoſe we call ſulphureous. This is particularly clear in the accounts given us of the rivulet called *Solforata* five miles diſtant from *Tivoli*, which has

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(a) Brown's Travels. *(b)* Lib. I. ch. 22. de natura eorumquæ effluunt ex terra & l. 3. c. 24. de natura Foſſilium.

a noiſome ſmell much like that of the ſulphur-well at *Knareſborough*, *(a)* which is further deſcribed by another Author *(b)* as "taking its origin from a neighbouring little lake of ſulphureous water called *Aqua Albula*, in which are the floating iſlands, is fourteen miles diſtant from *Rome*, and runs over a very white bed." And *Addiſon* in his travels ſays, that he ſmelt the ſtench of the waters of this rivulet ſome time before he ſaw them, and that the little lake which gives riſe to it lies in the very flat of *Campania*, and that, as it is the drain of theſe parts, 'tis no wonder that it is ſo impregnated with *Sulphur*, and that it has at the bottom ſo thick a ſediment of it that upon throwing in a ſtone the water boils for a conſiderable time over the place that has been ſtirred up; and *Niccolo Madrizzo* (*c*) affirms that the *Albula* derives its whiteneſs from the ſulphureous veins in its courſe: and to theſe agrees the following memorable teſtimony of *Elyſius de totius Campaniæ balneis* in the collection of the *Authores de balneis* publiſhed at *Venice*, ſhewing that here are natural magazines of *Sulphur*, and withall that the vapors of the water in the neighbourhood are ſo far from being unwholeſome that they are medicinal: *In ſummitate montis qui Puteolis ſupereminet, planities eſt in qua Sulphur conficitur, & ibi naſcens aqua ſulfuraria dicitur—hic tamen odor gravis & locus undique fumans terribilis eſt, cujus tamen fumus rheuma & frigus capitis aufert.* And the *Sulfurea Nar albus aqua* mentioned in *Virgil*'s 7th Æneid is another river of this denomination that empties itſelf into the *Tyber* agreeable to the white colour of the *Albula* above mentioned; from all which it abundantly appears that, not only the ſmell, but the white co-

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(a) Ray's Travels, Vol. I. p. 315. Lond. Ed. *(b)* Eſchinardi Agro Romano Parte 2d. Cap. 5to. *(c)* Viagii per Italia, &c. Venet 1718.

lour of theſe waters and their channels in *Italy* where *Sulphur* abounds, correſponds to the milky colour which the waters we call ſulphureous in theſe countries frequently aſſume, eſpecially on a little ſtagnation or before rain, particularly thoſe of *Moffat*, *Swadlingbar*, *Mount-campbell* and *Lucan* near *Dublin*, (to name no more) as likewiſe to the white glairy precipitate which theſe waters generally depoſit:

And this is abundantly confirmed by other obſervations made in other remote parts of the world, even in *America*, viz. *In* Canada *is a ſtream running from a mountain, which, when it rains, ſends forth an extremely diſagreeable and offenſive ſmell of* Sulphur: *The water itſelf is clear, but has a milky hue from a white pellicle which covers it, and becauſe it depoſits a whitiſh ſulphureous earth on the roots of the trees or pieces of wood in its channel, and when thoſe pieces of wood are well dried, they take fire as ſuddenly as common matches, and being burnt in a chamber, they emit a ſuffocating ſmell of Sulphur and burn with a blue flame, and the water is drank for the cure of the Itch and Tetters, and weakneſſes of the Stomach, and applied externally.* Guettard in the Memoirs of the Acad. of Sciences, 1752.

To this agrees very well the white glairy, and on drying, raggy and tenacious ſubſtance ſpontaneouſly precipitated by the waters called ſulphureous, a precipitate almoſt, not to ſay quite, as proper to theſe waters as the ochreous one is to thoſe of the chalybeate kind, as is notoriouſly the caſe of the lower hot ſprings of *Borſet* mentioned in the foregoing ſection from our Author, and the precipitate by him expreſsly acknowledged to be ſulphureous, and likewiſe of the ſeveral warm waters denominated ſulphureous in the province of *Bearn* in *France* and its neighbourhood lately enumerated and deſcribed by Dr. *Theophilus de Bordeu* of *Montpelier*, which agree perfectly to the cold ſulphureous waters of *Great-Britain* and *Ireland*, in exhibiting this white glairy, or raggy ſubſtance depoſited by them on the graſs, ſticks and ſtones over which they paſs, and likewiſe in their operation and effects on the human body.

Liſter, that learned and diligent naturaliſt, had indeed long ago pronounced this white matter to be a pure *Sulphur* in theſe words: *(a) Flos quidam albicans univerſis hujuſmodi aquis innatans, & circa oras iſtiuſmodi fontium ubiq; adhærens—merum Sulphur eſt.*

It muſt however be acknowledged that it is extremely difficult to collect a diſtinct, palpable *Sulphur* from moſt of theſe waters. Dr. *Jean Philippes de Limbourg* who publiſhed a treatiſe on the waters of *Spa* in 1756, obſerves indeed at the bottom of the baſon of the *Geronſterre* water, after it has remained a long time without being cleanſed, not a Rubric, but a white matter like what we are now ſpeaking of, being alſo found on the leaves of the trees growing near it, which on being burnt, emitted a manifeſt ſulphureous ſmell, but he ſays he could not procure flower of *Sulphur* from it by the retort.

Now as this is a matter of importance, a real palpable *Sulphur* from waters having but rarely, if ever, been exhibited, I ſhall here preſent the public with the reſult of an experiment made by Dr. *Francis Hutcheſon* Profeſſor of Chymiſtry in *Dublin* on the white matter above deſcribed, which was depoſited by the lately diſcovered water at *Lucan* near *Dublin*, which water in every other experiment anſwers to a ſulphureous impregnation, *viz.*

He put ſome of the dried white ſludge which had been precipitated on the ſtones near the well's mouth into a *Florence* flaſk in a moderate heat in a ſand a ſand bath, the heat being gradually increaſed for the ſpace of an hour; after all the moiſture was diſſipated, there was ſublimed into the neck of the flaſk, beſides a ſooty matter, a ſmall quantity of a yellow ſhining ſubſtance, manfeſting itſelf to be a real *Sulphur* by the blue flame and ſtrong and peculiar acid ſmell which it emitted on the red hot iron: and in ſhort by every other characteriſtic proper to that foſſile.

(a) De font. med. Angliæ, cap. xi.

But, not content to reſt a matter of this moment on the evidence of a ſingle experiment, I procured by the friendſhip of Dr. *William Henry* ſome of the like white ſludge collected from the ſtrong ſulphureous water at *Lawrie* near *Pettigoe* in the county of *Donegall*, which I recommended to be examined by a like proceſs as the former, to my good friend, the ingenious Chemiſt hereafter mentioned, to whom I owe ſeveral valuable hints on this occaſion, who put it into a bolthead placed on the ſurface of hot ſand, and in an hour's time there was ſublimed from it and found adhering to the upper part of the veſſel, and to the lower part of its neck, a viſible yellow flower of *Sulphur*, manifeſting itſelf further to be ſuch by the ſmell and by the bright blue flame it emitted in the preſence of three credible witneſſes.

Thus in a ſecond experiment was a palpable diſtinct *Sulphur* by ſublimation demonſtrated in the white ſludge depoſited by theſe waters; and moreover, the ſame thing was alſo ſhewn by Precipitation; for the ſame white ſludge dried, on its being digeſted either with Oil of Tartar or Limewater, and eſpecially the laſt, gave a yellow tincture having the ſmell and taſte of *Sulphur*, and when a few drops of ſpirit of Vitriol were added, it exhibited a milky liquor of a ſtrong ſulphureous ſmell, and precipitated a ſmall quantity of white grumes, which being collected in a filtring paper and dried, when the paper was ſet on fire, emitted a blue flame and ſmelt acid, like a Brimſtone match lighted. It is true, the quantity of precipitated *Sulphur* was but ſmall, and the precipitation ſlow, which was manifeſtly owing to the viſcid ſubſtance with which it was entangled, but that a real *Sulphur* was here preſent none that had been witneſs to the experiment would deny.

Upon the whole, it abundantly appears from the obſervations and experiments above related, that the waters commonly called ſulphureous do yield a palpable *Sulphur* both by ſublimation and precipitation.

Having ſo far inveſtigated a real *Sulphur* in waters, I ſhall here ſubjoin a few hints to ſhew that it may be demonſtrated alſo in ſome ſolid bodies where it has hitherto been only ſuppoſed. Doctor *Short*, who has made more experiments on mineral waters of all kinds than any one perſon upon record before him, and conſequently whoſe teſtimony is of the more weight, has aſſured me that by burning ſeveral ſorts of ſtones on the *Whitby* and *Scarborough* ſhores, and putting them into water he has made as ſtrong a plain Sulphur-water as any in *England:* and it is matter of obſervation that many of the ſulphureous ſprings riſe in the neighbourhood of Limeſtone, which perhaps may have ſome ſhare in their impregnation:

And as an inſtance of real *Sulphur* being more copiouſly diffuſed than is commonly imagined, I here preſent the public with a poſitive proof of real *Sulphur* lodged in and intimately mixed with the ſhining ſparry matter compoſing part of a ſolid rock of Limeſtone or Marble, which was communicated to a medical Society in *Dublin* by the ingenious *Patrick Bride* Chemiſt in the following Memoir:

" At *Oughterard*, about thirteen miles weſt of *Galway* there is a quarry of black Marble, and in the body of the ſtone are found large lumps of a whitiſh ſubſtance like the veins of white Marble, but of two, three, perhaps four inches diameter, of a ſparry appearance, and which will poliſh like common Marble: This forms a bank to a ſmall river that runs through it for about an hundred yards, in which ſpace only the ſaid white ſubſtance is found. This white ſubſtance evidently contains *Sulphur* in pretty large quantity, as appeares from the following experiment:"

" Being reduced into powder and thrown on an ignited iron, it burns with a blue flame offenſive to the noſe, like common *Sulphur*. I put two ounces of it in a common Hungary-water phial, with a ſmall glaſs inverted on it, and placed it two thirds deep in ſand, and a ſmall degree of heat elevated pure *Sulphur*, which condenſed on the ſides of the glaſs immediately above the hot ſand. The *Sulphur* thus obtained is abſolutely pure, and anſwers all the characters of the pureſt *Sulphur* imported from *Italy*: all the phlogiſtic part riſes with it, for the *caput mortuum* contains nothing inflammable. Lixivious ſalts or Lime diſſolved it, and it was precipitated by ſpirit of Vitriol."

And now, having above mentioned an Hypotheſis of our Author by which he would evade the evidence of *Sulphur* in the waters of *Aken* from the flowers of *Sulphur* they yield, I ſhall cloſe this Section with a Letter I received from a perſon converſant in theſe ſubjects, *viz.*

SIR,

IN Anſwer to yours deſiring my thoughts upon Doctor *L*——'s account of the production of *Sulphur* from the waters of *Aken*, *Borſet*, *&c.* and alſo upon the doctrine he lays down touching the miſcibility of *Sulphur* with water, I here ſend you what occured to me on the peruſal of his book.

The two Poſitions which the Author advances touching ſulphurated waters are theſe: firſt, that *Sulphur* in ſubſtance is not ſoluble or miſcible with water by any art without the intervention of alcaline ſalts or earths. The ſecond, that the waters of *Aken*, *Borſet* and others denominated ſulphureous, do not contain *Sulphur* in ſubſtance, but that the *Sulphur* found about the baths of *Aken* and *Borſet* is generated by the contents of thoſe waters after thoſe contents eſcape out of them.

I ſhall not detain you with conſidering the firſt of theſe poſitions, becauſe it is proved to be falſe by a poſitive Experiment evincing the contrary which you mentioned to me, but proceed to examine what he founds his ſecond Poſition upon: In doing this I ſhall begin with the facts which the Author admits in his own words, and then proceed to obſerve what facts remain ſtill undetermined, and which I apprehend muſt be determined by Experiment before the Author is warranted to draw the concluſion he has done.

In Part III. p. 33. §. 77, of the *Eſſay on Waters* are theſe words: "*Beſides, the vapor of the baths of* Aken, *as well as the lower ſprings of* Borſet, *yield plenty of the pureſt* Sulphur, *in a manner hitherto falſly looked upon as a ſublimation, but which ſhall be ſet in a different light and explaned in its place.*"

In Part III. p. 53. §. 160, he ſays "The *Baths, eſpecially newly filled, ſtrike the organs of ſmell with a moſt ungrateful odour, which may be truly called ſulphureous, as will appear when we come to ſhew that it carries with it, if not actual particles, the eſſential or component particles of that mineral.*"

In Part III. p. 69. §. 195, he ſays, "*But I am induced to think that there is no* Sulphur *actually or ſubſtantially diſſolved in the water, but that the principles*

ciples of that foſſil, viz. *the Acid and Phlogiſton, are blended with the waters.*"

In Part III. p. 72. §. 205, he ſays "*Its production cannot, in my judgment, be accounted for in any other manner than that of a generation, which is eaſily conceived when the component parts of* Sulphur *are demonſtrated in the waters.*"

Here then is a full, direct and explicit acknowledgment that theſe waters yield plenty of the pureſt *Sulphur*, that they contain the principles or component parts of *Sulphur*, and that theſe principles or component parts are the *Acid* and *Phlogiſton*; from all which it muſt be evident that nothing remains in conteſt between the Author and his oppoſers but the method by which this pureſt *Sulphur* is produced from theſe waters; ſo that, the Author having thus reduced the debate to one fact, I ſhall proceed to examine how he explains this in its place, as he promiſes in the firſt cited paragraph.

In this paragraph he alſo aſſerts that this production has hitherto been looked upon as a ſublimation, and promiſes to ſet it in a different light and explain it. It muſt be confeſſed that he has ſet this matter in a different light, but whether this different light be the true or falſe one in which the production of the *Sulphur* which he acknowledges in theſe waters ought to be viewed and explained, may appear from the following obſervations:

In Part III. p. 67. §. 191, we meet with the following paſſage preparatory to his explanation of this Production: *But in theſe waters there is not ſo fixed and permanent an union of the Acid and Inflammable principle till both fly off together, and uniting form the* Sulphur, *which till now has been looked upon as flowers of* Sulphur, *the product of ſublimation, which I ſhall demonſtrate to be abſurd, as it is impoſſible.*

In this paragraph the Author lays the foundation of the neceſſity of his having recourſe to ſome other ſolution of this production of *Sulphur* than Sublimation, even by pronouncing it to be both abſurd and impoſſible to be by Sublimation, nay, he promiſes a demonſtration of this abſurdity and impoſſibility: and indeed, when I had proceeded ſo far in the Author's work and met with this poſitive aſſurance of ſuch a demonſtration, I concluded that the matter in queſtion would have been by Experiment cleared from every poſſible objection, (Experiment in my apprehenſion being the only poſſible method of demonſtration in ſuch a caſe) but to my great ſurprize, after reading his book with my beſt attention in ſearch of this demonſtration, I have not been able to find one ſtep of it.

In a ſubſequent page, *viz.* §. 195. p. 69, he endeavours to explain this production of *Sulphur* in more expreſs terms, *viz. The principles of* Sulphur, viz. *the Acid and Phlogiſton, are blended with the waters, yet not ſo as to come into ſuch a contact as is neceſſary to occaſion the union requiſite for the production or generation of actual* Sulphur *till both theſe volatile parts flying off together, are confined in the vapor in the vaults, ſo as the union and conſequent generation is readily brought about:* Such is the light in which our Author has thought fit to ſet this matter.

Now I am not about to take upon me to determine how this *Sulphur* is produced, but to ſhew that the Author's different light is full as obſcure, and the generation of the *Sulphur* according to the above profeſſed explanation of it as abſurd and impoſſible, if not more ſo, than by Sublimation, notwithſtanding the promiſed Demonſtration to the contrary.

To this end I muſt obſerve that in the two laſt cited paragraphs there is an affirmation that the *Acid*

Acid and Inflammable principle both fly off together, by which it muſt be underſtood that both theſe principles are in theſe waters equally volatile. But the Author has not produced any experiment either of his own or others to prove this fact; and there can be no doubt but he muſt find it difficult, if not impoſſible, to produce any ſuch experiment, becauſe there is no fact in Chemiſtry better aſcertained by experiment than that the univerſal Acid, one of the component parts of *Sulphur,* is extremely fixed, and that it requires a degree of heat greatly above that of boiling water to render it volatile, an heat, by the Author's own confeſſion vaſtly greater than the heat of the water of theſe ſources: And it is equally well aſcertained, and even confeſſed by our Author, that the *Phlogiſton* or Inflammable principle, the other component part of *Sulphur* is extremely volatile, and diſſipated with the ſmalleſt degree of heat; and yet the Author pronounces that they *both fly off together*, without ſo much as attempting to ſhew by what means they become of the ſame preciſe degree of volatility, (which they muſt be in order to fly off together) or, telling us, if they are not preciſely of the ſame volatility, which is the moſt volatile and flies off firſt, and where that firſt more volatile component part waits for the other leſs volatile component part which flies off after it; and poſſibly the eſtabliſhing of this fact might have made one ſtep of the promiſed Demonſtration.

But there is another fact ſtill more eſſential, to be eſtabliſhed, than the equal volatility of the two component parts, *viz.* that the univerſal Acid, one of the component parts of *Sulphur*, in a volatile ſtate, and in the open air, would generate actual *Sulphur*, with the *Phlogiſton*, the other component part, and poſſibly this fact might have furniſhed another ſtep of the Demonſtration; and if the

Author's knowledge of natural bodies were as extenſive as throughout his whole book he would have us think, he poſſibly might have diſcovered ſome Experiment to ſupport his opinion; but as he has not condeſcended to inform us better, we muſt, I fear, ſubmit to the information of *Stahl*, *Junker*, *Langius*, *Neuman* and others who have given us the greateſt number of Experiments upon the univerſal Acid in a fixed and in a volatile ſtate, and to the entire overthrowing of this profound Chemiſt's new doctrine of Generation, have determined that the univerſal Acid in a volatile ſtate, will not generate *Sulphur*:

Langius's words are theſe: "(a) One of the properties of the univerſal Acid is to form *Sulphur* when we combine it with the *Phlogiſton*, in its fixed ſtate, whereas the volatile Acid (*i. e.* the univerſal Acid in a volatile ſtate) cannot yield a ſimilar production, becauſe it is greatly attenuated in its compoſition with the *Phlogiſton*, and this is the reaſon that when we pour the volatile Acid ſaturated with an Alcali upon lighted coals, it does not excite a ſulphureous ſmell as the ordinary vitriolic acid does in the like circumſtances: this phenomenon merits the utmoſt attention."

Here then is an Experiment which contradicts the Author's firſt principle in point of fact, which he muſt remove out of the way before he can be allowed to conclude that the *Sulphur* of theſe waters is a Generation by the union of the Acid in a volatile ſtate and the *Phlogiſtion* after they eſcape out of them; for it clearly follows, that, if *Langius*'s obſervation be true, the Author's Generation is impoſſible, and therefore the advancing or ſuppoſing it abſurd:

But his precipitancy in pronouncing it to be a Generation is not leſs conſpicuous from the above ex-

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(a) Supplement to Junker's Conſpectus Chemiæ.

experiment of *Langius* than from the artificial generation of *Sulphur*: for it is proved by the Chemiſts (*a*) that for the artificial generation of *Sulphur*, the univerſal Acid, one of the component parts, muſt be in a concentrated ſtate, (*i. e.* as near as can be, entirely free from mixture with water) and that before the generation is brought about, it muſt be heated to a degree vaſtly greater than the heat of boiling water. How then can a generation of *Sulphur* be brought about in the air that is in the vaults over theſe ſources? or in a degree of heat ſo much leſs than the heat of boiling water?

Nay, what is ſtill more extraordinary, the Author himſelf points out to his readers this very generation of *Sulphur* here ſpoken of, for Part III. p. 34. §. 79, you will meet with this paſſage: "*that* Sulphur *conſiſts of theſe parts, (viz. the univerſal Acid and inflammable Principle) is alſo proved by the artificial generation of* Sulphur, *by fuſing any neuter ſalt compoſed with the vitriolic acid, and throwing into it any inflammable body, the reſult of which will be a dark-coloured maſs, which partly diſſolves in water, gives a fetid ſmell and a yellow tincture, which is precipitated with acids in the form of a Magiſtery, which fuſed gives perfect* Sulphur.

Theſe are the Author's own words, and indeed it is not a little ſurprizing that he has omitted to explain and diſtinguiſh by experiment, if he could, between the artificial Generation here pointed out and the Generation ſuppoſed by him in the Poſition under examination, wherein the Acid is in a volatile, non-concentrated dilute ſtate.

Upon the whole, what muſt be ſaid to a man who, after declaring that he *ſet about determining the important queſtion* (meaning as to the exiſtence of *Sulphur* in the waters of *Aix-la-Chapelle* and

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(*a*) Neuman's Works, p. 172. and Maquer's Elem. of Chymiſtry, p. 236. Vol. I. Eng. Ed.

Bath) with all care and caution, determined to take nothing upon truſt, and yet takes the very principal point in debate upon truſt, that is, without proof by experiment?

Notwithſtanding this unphiloſophical method of proceeding, it is clear from the whole tenour of his book that he intended to paſs himſelf upon the world for the moſt able Phyſician and Chemiſt, juſt as he affirms numbers of Phyſicians paſs upon the credulous, undiſtinguiſhing populace, whoſe characters the diſcerning Author has drawn at full length in the following words:

In theſe days it is no wonder we find numbers of Phyſicians entire ſtrangers to the nature and qualities of ſome of the moſt valuable ſimples, and not daring, where they happen to know and eſteem a ſimple, common medicine, to preſcribe it, when they ſee a vulgar prejudice take up arms againſt it, or find the popular folly ſuch as to eſtimate the Phyſician, as is frequently the caſe, from the rarity, expence or complicated preparation, or perhaps the inſinuated or imagined myſtery of the medicine he preſcribes; or to make men run after a jugling ſecret-monger, who is not in knowledge or rationality three degrees removed from the brute that draws the gilded chariot, in which he rides triumphant over phyſic, truth and common ſenſe. Who, in ſuch times, will preſume to preſcribe a plane, ſimple remedy familiarly known to old women and nurſes?—The ſenſible, judicious, honeſt Phyſician, who prefers the good of his patient and the peace of his own conſcience to riches or the favour of a populace, which are too rarely obtained by better arts than temporizing, adulation and ſervility. Had the phyſical world been better ſtocked with men of this caſt, or the populace more diſcerning, we ſhould ſee fewer Quacks and other Knaves make fortunes by the ſpoils of a deluded people; and medicines would not be rated by their rarity, as men are often by the tinſel on their gar-

ments, the magnificence of their houſes, or the ſplendour of their equipages.

It ſeems to me that the Author would have conducted himſelf with more modeſty, if, not content with the opinions of others touching the *Sulphur* of theſe waters, nor able to ſupport his own by experiment, he had concluded upon them as he has upon thoſe of the *Pouhon* Spa, by ſaying that they were the work of the ineffable and inimitable chemiſtry of Nature.

I am, Sir, Yours, &c.

SECTION IV.

A DISQUISITION *concerning* Sulphur, Phlogiſton, *and* Gas ſulphuris *or the volatile Acid of* Sulphur *diſtinctly as ingredients in Waters, and particularly in* Bath *water, with its Compariſon to that of* Aix-la-chapelle. *The fallacy and inconcluſiveneſs of the arguments advanced againſt the exiſtence of either* Phlogiſton *or* Sulphur *in* Bath *waters.*

OUR Author undoubtedly is ſo far in the right, that *Sulphur* does not ſo predominate in *Bath* waters as to be equally obvious to the ſenſes as in *Harrigate* or *Aix-la-chapelle* waters; but his vehemence againſt the Brimſtone-mongers has ſurely tranſported him beyond the bounds of moderation when he attempts to ſtrip them even of *Phlogiſton*, of which that they really do partake as well as of the volatile vitriolic or *ſulphureous* Acid, ſhall be ſhewn from his own experiments, or in his own terms, that the *Bath* water as well as that of *Aken*, really contains the principles of *Sulphur*.

And as the *Bath* water is very frequently preſcribed in chronical caſes, and is ſometimes tranſported for this purpoſe, I apprehend theſe altercations about its contents will be of the more moment,

ment, as they may ſerve to ſettle ſome points that have been controverted concerning its uſe at the fountains and at this diſtance from them :

And firſt of all, I myſelf do ſtand moſt chearfully corrected by our Author, in having ſuppoſed and publiſhed, as I did implicitely from the authority of others, that the *Bath* water might owe its curdling of milk to a volatile vitriolic *Gas*, whereas he informs us (what is found true by experience) that it curdles milk in *London*, as it does alſo here in *Dublin*, ſo that where a *Bath*-water poſſet may be of uſe, it may be ſupplied here as as well as there ; and moreover, it is but doing juſtice to our Author to acknowledge, that he has given uſeful inſtructions *(a)* how to bottle *Aken* waters ſo as to preſerve their *Phlogiſton* when tranſported to *London* with very little change more than that of heat ; and the ſame thing holds true of *Bath* water when carefully bottled and ſent to us in *Dublin* ; for in the ſequel of theſe obſervations it will appear that this water, even here, gives every mark of *Phlogiſton* with ſolution of Silver, ſolution of Mercury ſublimate corroſive and ſolution of green Vitriol, as at the fountain, ſo that it retains more of its original qualities even as at the fountain than is commonly ſuppoſed : for, as to the Iron, it is well known that it is but ſlightly impregnated with it at the fountain, nor does it ſhew any veſtiges of it here by the precipitation of any ochreous matter : on the contrary the bottoms of the bottles are clean. *(A)*

(a) Eſſay on Waters, Part III. p. 99, 100.

(A) The Experiments here hinted at, were made on the *Bath* water in *Dublin*, ſome of which had been bottled three months, others ſix months, imported by *Thomas Johnſton* Apothecary, whoſe diligence and accuracy in procuring and preſerving theſe and other Waters, deſerve the acknowledgment of the public.

Theſe inquiries will be yet of the more importance, as they will aſſiſt us in our reaſonings on the operation and effects of a water ſo often uſed: for indeed if our Author's repreſentation of the *Bath* water be juſt, *viz.* that it is no more than a warm ſubacid Chalybeate, impregnated with a neutral, bitter and a muriatic ſalt, not differing from our common purging Chalybeates, but in the heat and proportion, not in the qualities of the ingredients (*a*), it's effects are not to be explained on any other principles: but if, beſide thoſe, there enters into the compoſition a balſamic matter, as from the experiments elſewhere (*b*) related, and from the peculiar milky ſoftneſs obvious to our taſte in *Bath* water both at the fountain and at this diſtance from it, is highly probable, it will be no raſhneſs to attribute unto it other effects than what belongs to any meer purging Chalybeate heated:

And if there be moreover, either *Sulphur*, or *Phlogiſton*, or a *Gas* or volatile Acid of *Sulphur* combined with the *Phlogiſton* in this water, it muſt have a greater energy and activity than if it were entirely deſtitute of ſuch ingredients, as our Author would perſuade us: and although the *Sulphur* ſhould exiſt but in a very ſmall quantity and in a very ſubtilized ſtate, this would be no argument of its inefficacy: for *Sulphur* is found, even in many of the cold waters in ſo ſubtilized a ſtate as to be utterly incapable of being collected either by diſtillation or precipitation, which waters are yet found to be very powerful medicines in divers caſes: and that a combination of *Sulphur* with Iron, tho' in very ſmall quantity and in a very ſubtilized ſtate in a water, diverſifies its effects and adds greatly to its activity, we have a notable inſtance in

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(*a*) Eſſay on Waters, Part III. p. 335.

(*b*) Method ſynops. of min. Waters, p. 593. 597.

in the *Geronſterre* water compared to that of *Pouhon*, even in the different effects of the firſt, which being impregnated with a greater ſhare of *Sulphur* combined with its Iron, is found to be far more active, *(a)* more animating in relaxations, palſies and oedematous tumors, and particularly, more eminent in fixing the Gout: and how far it may be reaſonable to attribute the ſuperior efficacy of the *Bath* water to a ſubtile *Gas* or ſulphureous Spirit, being an extremely volatile and elaſtic fluid, giving activity to the more inert materials, I ſhall endeavour to ſhew in the ſequel, by giving ſeveral experiments and obſervations on it, the reſult of recent inquiry.

That a volatile Acid of *Sulphur* is a frequent ingredient in waters where *Sulphur* in ſubſtance cannot be exhibited, being wholly diſtinct from the aerial fluid manifeſting itſelf by the ſparkling bubbles in theſe and even in many ſimpler waters, I am convinced by obſervation; and, as there has been not a little confuſion in authors in relation to theſe two articles, I ſhall here adopt the account given of the *Acidum Sulphureum vel potius Vitriolicum volatile*, or of the volatile ſulphureous or rather vitriolic Acid in a Supplement publiſhed by *Langius*, at the end of a *French* tranſlation of *Junker*'s *Conſpectus Chemiæ* in the year 1757, deſcribing its origin, and diſtinguiſhing qualities from him; and to this ſhall annex ſome experiments I made on it with the utmoſt care and attention, in order to make ſome further inveſtigation of its properties, with a view to ſhew with a ſomewhat greater degree of preciſion than has yet been done, how far this ſubtile Acid may be an ingredient in waters, and the rather as from the great energy and activity of this principle they may be ſuppoſed to derive a good deal of their powerful effects.

(a) See Limbourg Traite des Eaux de Spa.

"This volatile Acid is obtained by ſlowly deflagrating *Sulphur* in a cucurbite, whoſe belly is very large and neck very ſtreight, and pierced in ſeveral holes where the belly begins to leſſen, into which water being poured, a ſmall veſſel full of *Sulphur* is placed ſo as that the margin of it may almoſt touch the water, which being lighted by a ſmall match, and the ſuperior orifice being cloſed, the *Sulphur* conſumes ſlowly, even ſo ſlowly, that an ounce is not conſumed in leſs than ſix hours, by which means the Acid is united to the *Phlogiſton* or inflammable principle in the moſt minute moleculæ, and by this union rendred volatile."

"It may alſo be formed by the fumes of Oil of Vitriol, in diſtilling, eſcaping by ſome crack in the veſſel and uniting themſelves with the vapors of the burning coals, which is the ſame volatilized Acid as that above from the ſlow deflagration of *Sulphur*."

"This Acid is entirely diſtinct from common Spirit of Vitriol, whoſe volatility proceeds only from the phlegm it contains, and in containing an inflammable ſubſtance, which common Spirit of Vitriol does not."

"It is alſo diſtinct from *Sulphur*, whoſe Acid is fixed, and the phlogiſtic principle in much greater quantity and more cloſely united."

"But the union of the *Phlogiſton* and Acid in the volatile vitriolic Acid is more lax than in *Sulphur*, ſo that if it be expoſed in a warm atmoſphere and a large veſſel, the acidity exhales and leaves an inſipid phlegm, nor does it cloſly combine itſelf with Spirit of Wine rectified, but is quickly diſſipated in the air, flying off."

"It is further diſtinguiſhed from the fixed vitriolic acid by the ſmell, which diffuſes itſelf to a diſtance, is ſuffocating and incommodes the breaſt, whereas the fixed vitriolic acid has no ſmell."

"Again, the fixed vitriolic Acid is almoſt cauſtic on the tongue, but the volatile vitriolic Acid when depurated has ſcarce a ſenſible acidity, but a certain roughneſs on the tongue; and laſtly the elaſticity of the volatile vitriolic acid is ſuch that it will burſt a bottle cloſe ſtopt in heating. (*a*)"

So far *Langius.*

I procured the volatile Acid of *Sulphur* prepared by diſtillation from *Patrick Bride* Chymiſt, and the volatile Acid of Vitriol prepared by Dr. *Francis Hutcheſon*, Profeſſor of Chymiſtry in *Dublin*, anſwering to moſt of or all the characters of that above deſcribed by *Langius*, and with it made the following experiments ſhewing that tho' it falls ſhort of producing the ſame effects to the ſame degree as *Sulphur* in ſubſtance does, it produces effects on Metals and their Solutions which the ſimple Acid does not, until it be combined with the *Phlogiſton*, which effects are alſo in a great meaſure common to *Sulphur* in ſubſtance.

I ſuſpended a Silver ſpoon in the vapor of the above-mentioned volatile Acid of Vitriol in a narrow mouth'd jug for the ſpace of a week without any effect, which was alſo the caſe of another Silver ſpoon kept immerſed in the liquor: but when the concave part of the ſpoon was placed upon the mouth of a gallypot full of this volatile acid in a ſand heat and kept there about two hours, it was tinged of a dark brown and faint copper colour, appearances agreeable to the effects of the vapor of ſolution of *Sulphur*, altho' theſe diſcolorations by the volatile acid are leſs deep than thoſe from the vapor of the ſolution of *Sulphur* artificial or natural, and particularly leſs deep than thoſe produced by the vapor of our ſulphureous water

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(*a*) Lightening has in ſome meaſure effects ſimilar to thoſe of the volatile ſulphureous Acid, both with reſpect to the exploſive power and to the diſcolouring of metals.

at *Lucan* near *Dublin*, which, without any heat applied, tinged a ſilver ſpoon expoſed to the ſteam of it in a jug whoſe mouth was ſtopt, of the colour of lead in the ſpace of 48 hours.

At the ſame time the effects of the above *Gas*, or volatile acid of Sulphur or Vitriol on ſeveral of the metallic ſolutions are ſo far different from thoſe of the fixed acid of Sulphur or Vitriol that the ſaid *Gas* being diluted with diſtilled water, in repeated experiments, did never fail to produce various diſcolorations with the ſolutions of Silver and Mercury, even ſuch as are proper to ſolutions of *Sulphur*, more or leſs according to the ſtrength of the impregnation, as is ſhewn in the Table annexed: but the fixed acid of Sulphur and Vitriol, *viz.* the Spirit of Vitriol and common Oil of Sulphur by the bell, equally diluted had no effect on thoſe metallic ſolutions, *viz.* by reaſon of the laſt named acids being not combined with the *Phlogiſton*; a fact that may well merit the attention of the curious in explaining the appearances ariſing on the mixture of the metallic ſolutions with ſeveral waters where *Sulphur* cannot be diſtinctly demonſtated.

Langius before quoted proceeds to obſerve that Nature produces ſomething like the above volatile ſulphureous or vitriolic Acid in the decompoſition of the *Pyritæ* and other ſulphureous bodies, and that it is furniſhed by the greateſt part of the *Acidulæ* and *Thermæ*, but with this difference, that it is not ſo volatile or ſo ſtrong as the above artificial Acid, and that the *Grotto del Cani* near *Naples*, and another cavern near *Pyrmont* are the two moſt remarkable places known for this volatile acid or ſulphureous Spirit, in the latter of which places it appears in the form of a cloud or vapor, which ſeldom aſcends more than two feet above the ground, and ſuffocates not only birds and inſects, but alſo quadrupeds if long expoſed to it; and if a man plunge his head down to the bottom of the cavern, he percives a penetrating ſulphureous ſmell, becomes giddy, drowſy and in danger of being ſuffocated: and I am well aſſured that the Damps in Mines kill with ſtupefaction: ſuch are the effects of the native volatile ſulphureous Acid when acting in its full force; and that the *Pyrmont* water, one of the richeſt of all the Chalybeates, is impregnated with it, we may conclude from the ſulphureous vapor which is perceived at the wells, (*a*) which makes the water-ſervers giddy, and which alſo cauſes the fiſh, frogs, ducks and goſlings when thrown into theſe wells to become giddy, loſe their ſtrength, and at laſt fall down and ſink, and which alſo affects mankind in drinking it with a kind of drunkenneſs, a not unfrequent effect alſo of our Chalybeate waters and owing to the ſame cauſe in a leſs degree; for indeed that an extremely ſubtile and volatile acid enters into the compoſition of our ordinary Chalybeate as well as other mineral waters has been ſhewn elſewhere by divers obſervations formerly made, and which have been ſince confirmed in Dr. *Lucas*'s experiments in his *Eſſay on Waters*. In this place it ſhall ſuffice to mention but one inſtance to this purpoſe: Dr. *Whiſtler*, an eminent Phyſician, who frequented *Tunbridge* waters many years, mentioned by Dr. *Baynard*, uſed to ſay that in a dry ſeaſon he could manifeſtly taſte a *Gas Vitrioli* in them.

And as this is a volatile and powerfully elaſtic fluid capable of producing thoſe miſchievous effects on animal bodies above-mentioned when collected and acting in its full force, there is good reaſon to believe that in a reſtrained degree, it may produce great and good effects, in giving activity to the element and other more inert materials.

(*a*) Method. ſynops. of min. Waters, p. 313. 314.

Now the *Bath* water is an illuſtrious inſtance of ſuch an impregnation both by the taſte and ſmell, as appears from the following authentic teſtimonies:

Firſt Dr. *Baynard*, a learned Phyſician, and many years reſident at *Bath*, affirms (*a*) that it had been often obſerved, that in a great drought and the wind at or about N. E. the *Bath* waters have been not only ſenſibly hotter, but acidulated and abounding with a *Gas Vitrioli*, not unlike the grateful acid of the *German* Spaw water; and an old guide told him he had obſerved the ſame thing a hundred times in bright, ſerene weather, and when the wind blew freſh from ſome northerly point: And that the organ of ſmelling is under the like circumſtances affected by the vapor of *Bath* water as by that of *Sulphur*, appears from the following obſervation of the Gentleman hereafter mentioned who reſided for a conſiderable time at *Bath*:

The water being brought into his room every morning in a tin can uſed at *Bath* for keeping the incloſed bottle warm, on entering the room, it immediately diſcovered a ſmell of *Sulphur*: his wife, daughter and ſervant firſt obſerved this by the ſmell, and afterwards by the taſte, and himſelf by both at once: but this was only perceived in froſty mornings, (when the vapors are condenſed) for in cloudy or wet mornings it diſcovered very little ſulphureous either to the ſmell or taſte.

But Dr. *Lucas*'s own teſtimony with reſpect to an impregnating volatile Acid is ſtill more expreſs and ſtrong, *viz.* " (*b*) *In the King's bath pump room the firſt thing that preſents itſelf to our obſervation in this water is a ſubtile Acid which flies off in the vapor, ſometimes ſenſibly ſtrikes the noſe, and always*

(*a*) Of cold Baths, p. 190, and in the Appendix, p. 431.
(*b*) Eſſay on Waters, Part III. p. 277.

proves very offenſive to weak lungs, (agreeable to the deſcription *ipſiſſimis verbis*, given by our Author Part III. p. 33, of the effects of the vapor of Sulphur in fuſion and of the volatile ſulphureous or vitriolic Acid both natural and artificial above obſerved) *and powerfully corrodes all the iron works in and about the Baths.*"

Now ſince the *Phlogiſton* is allowed by our Author to be the cauſe, not only of inflammability, but of colours and odours in bodies, and is what gives ſmell and volatility to the Acid of Sulphur or Vitriol, which ſimply is entirely inodorous, it follows from his own teſtimony, that the *Phlogiſton* ſubſiſts combined with the Acid in the vapor or volatile parts of *Bath* waters as well as thoſe of *Aken*.

So much of the volatile parts of *Bath* water: let us next conſider its more fixed parts; and firſt what our Author (*a*) calls the *light black Mud or Earth*, which is found in the ciſterns, and partly depoſited by the waters in the corners of the baths, and ſeems to bear a conſiderable analogy to the light black mud which is alſo depoſited in the baths, reſervors, aqueducts and canals at *Aken (b)*, the colour of which he aſcribes in a great meaſure to the *Sulphur* falling to the bottom and augmenting the colour and volume of the ſediment; and here indeed he agrees to other Authors, who have examined the bituminous and ſulphureous waters, who make the black colour of the earth or ſludge in their courſe to be peculiar to theſe waters (*c*), which alſo agrees to the analyſis of *Sulphur*, which both on being diſſolved in an alcaline lixivium and on being deflagrated, is obſerved always to leave a black fixed earth or ſediment *(d)*: So that as

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(*a*) Eſſay on Waters, Part III. p. 276. *(b)* Ibid. p. 57. (*c*) Memoires de l'Acad. royale, A. D. 1762, p. 1083; and Short's Hiſt. min. Waters, Vol. I. p. 312. *(d)* Shaw's philoſ. principles of univerſal Chymiſtry.

far as we may be allowed to reaſon from analogy, the light black Mud of the *Bath* waters is of a ſimilar nature; and if our Author had examined that ſubſtance without partiality, he would probably have been a little leſs peremptory in pronouncing it not to be a mineral production, as he allows the *Aken* mud to be, but a meer vegetable matter putrified: for, tho' he tells us that it yields nothing like *Sulphur* in ſublimation or diſtillation, this may be eaſily accounted for from the ſmall quantity of the *moleculæ* diſperſed among the calcarious and other matter, which may be illuſtrated by a ſimilar obſervation upon the black ſediment of our ſulphureous water at *Lucan* near *Dublin*, which tho' it be of a ſtrong ſulphureous ſmell, yet, being carefully diſtilled by a mild heat, yielded no flowers of *Sulphur*, altho' the white glairy ſubſtance depoſited by the ſame water did, and for this obvious reaſon, it's being more free from heterogeneous mixtures.

Now the Mud of *Bath water*, upon a careful examination of it on the ſpot, and of a ſpecimen of it tranſmitted to *Dublin*, is found ſometimes when firſt taken up, to be green, an equivocal mark common either to a vegetable matter, (as perhaps ſome portion of the *Conferva* mixed with it, or to *Sulphur*, or both) but by keeping, it turns aſh-coloured and ferments briſkly with Acids, and on being roaſted in the crucible it loſt the aſh-colour, and acquired a brown rediſh caſt, appearances ſimilar to thoſe exhibited by the blue and black Marls, (*a*) which in the language of the vulgar, contain ſome pittance of *Sulphur* ſoon diſſipated by the fire, ſo that this Mud appears plainly to be not a purely vegetable production, but partly of the mineral or calcarious kind with a ſmall

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(*a*) Hill's Hiſtory of foſſils.

quantity of that ſubſtance which tinges it black and aſh-coloured:

But it were doing injuſtice to this Precipitate of the *Bath-waters* to ſuppreſs on this occaſion an experiment of *Guidott* (whom our Author calls the head of the analyſers or rational writers on theſe waters) thus circumſtantially related, (and which amounts to a more direct evidence of real mineral Sulphur entering into the compoſition of this Mud) *viz.* " *The* (*a*) *foul contents of the* Bath *being put into a crucible for calcination, before the* marly *or* muddy *parts were conſumed, the crucible being then opened and the contents touched with a ſpatula, gave a very ſtrong ſtench of Brimſtone, and burnt as blue as ever I ſaw any* Sulphur." To which I add, that a ſix-pence having been kept in the Mud of the *King's bath* in a moderate heat, and become black thereby, and then tranſmitted to me in *Dublin* was of a dark blue and copper colour, being the colours ordinarily given to Silver by the waters called ſulphureous.

Theſe obſervations placed together may ſuffice to ſhew the analogy of *Bath*-Mud to that of other waters called ſulphureous.

But the point of the exiſtence of *Sulphur* in another of the ſubſtances ſpontaneouſly ſeparated from the *Bath* waters, *viz.* the *Bath-Sand*, a mouldered *Pyrite* (being a compoſition of *Sulphur*, Iron, and calcarious Earth, and which he pronounces to be the cauſe both of the heat and impregnation of theſe waters) is fairly given up in theſe words:

" *The* Bath-Sand *thrown* (*b*) *into an ignited crucible emits a ſtrong ſulphureous vapour, and a blue flame ſuddenly diſappearing, ſo that it is hardly per-*

(*a*) Treatiſe of Bath Waters in Engliſh.

(*b*) Eſſay on Waters, Part III. p. 270.

ceptible to the ſight. (A) *The vapor collected in a glaſs bell condenſes and ſhews itſelf to have been none other than the vitriolic,* (or in other terms *ſulphureous) acid.*" And to this agrees what I am well aſſured of, as a well known fact at *Bath*, that this Sand thrown upon a red hot iron ſends forth a ſmell equal to that of a lighted brimſtone match, and the ordinary iron Pyrite, according to *Henkel*, contains $\frac{1}{3}$ or $\frac{1}{4}$ of *Sulphur*.

Here let me obſerve the great difference between this ſubſtance and the reſiduum of the *Thames* water, *(a)* which (as containing not a ſulphureous but *Oily matter)* in a well ignited crucible gives no ſenſible acid vapor nor blueneſs in the flame, but a ſmell as if oil or greaſe had been burning.

Thus it appears that the very matter ſuppoſed to impregnate the *Bath* waters contains the *Phlogiſton* or inflammable principle united to the Acid, not only laxly, as in the *Gas ſulphuris* or volatile ſulphureous Acid, as above, but cloſely, and ſo as to require a ſtrong fire to ſeparate them, ſo that here appears, even from our Author's own teſtimony, in the *Bath*-waters, 1. The acid of *Sulphur* volatilized by and combined with the *Phlogiſton.* And 2dly, *Sulphur* in ſubſtance from the impregnating *Pyrite*, which by the accurate *Walerius* is defined, *Sulphur ferro mineraliſatum.*

This is one notable inſtance of *Sulphur* diſſolved in water by the chymiſtry of Nature, without the intervention of an Alcali, and ſo beyond the ken of our Adept, altho' it is above ſhewn that Art can effect the ſame thing alſo without the help of an Alcali, concerning which artificial ſolution it is

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(A) Thomas Haviland Apothecary, got ten drams of a very volatile acid ſpirit from ſix pounds of the Sand taken from the ciſtern in the *King's bath.*

(a) Eſſay on Waters, Part. I. p. 134.

obſervable that it has not the ſmell proper to a ſolution of *Hepar ſulphuris* or like that of *Aken* water and many others any more than *Bath* water; ſo that *Sulphur* may be inviſibly ſuſpended in water without affecting the ſmell in the ſame manner as that wherein the ſolution is effected by an Alcali, and conſequently the argument drawn of the abſence of *Sulphur* from the want of ſuch a ſmell is fallacious.

I proceed next to conſider what evidence is given by the *Bath* water itſelf of the preſence of either *Phlogiſton* or *Sulphur*, neither of which our Author, *(a)* (to uſe his own words) with *poſitive aſſurance concludes is found in* Bath *water, whatever men unacquainted with the principles of chymiſtry and nature——or who might have thought themſelves intereſted in concealing the truth, might have heretofore, now do, or hereafter ſhall ſet forth to the contrary.*

Not intimidated by this Menace, I ſhall however examine his experiments, and humbly hope to make a better uſe of them than he has done, endeavouring on the one hand to guard againſt a precipitate concluſion from a ſingle experiment, and on the other by a careful compariſon of the ſeveral experiments together, and by viewing the ſeveral evidences or want of evidence of the *Phlogiſton* in various lights, to draw a juſt inference or induction from the ſeveral particulars.

I ſhall begin with that Experiment in which he ſeems to place the greateſt confidence, and upon which he builds his triumphant declaration above quoted, *viz.* *(b)* *The ſolution of lead cauſes in* Bath *water the moſt perfectly bright, white clouds, and at length a lovely white magiſtery*, and therefore it contains neither *Sulphur* nor *Phlogiſton*, becauſe, *had there been any portion of theſe in the water, mud-*

(a) Eſſay on Waters, Part III. p. 307. *(b)* Ibid.

dy, yellow, or dark brown or black clouds muſt have been the conſequence of the mixture."

In anſwer to this, I beg leave to illuſtrate the force of this reaſoning, by applying it to the inveſtigation of the preſence of another foſſil, to which, if it be juſt, it muſt be applicable as well to *Sulphur*; and that is Iron-Mine. Every body knows that the attraction by the Load-ſtone is a ſure teſt of the preſence of Iron in any mineral to be examined: but ſuppoſe any Operator on theſe minerals, upon his ſubjecting any of them to this teſt, finding it to fail, ſhould inſtantly conclude that it contained no Iron, would he be ſafe in his concluſion? Not at all: for it is found upon tryal that there are Ores very rich in Iron which do not yield to the magnet, of which *Walerius* in his *Mineralogie* has given divers inſtances: but to come directly to the point:

If a man were to ſet out with a determination to demoliſh both *Sulphur* and *Phlogiſton* in water and his evidence were to reſt upon one ſingle experiment, he would be much in the right to chuſe that experiment or teſt of the preſence of *Sulphur* or *Phlogiſton*, which might be the moſt likely to fail, and to omit, or not to inſiſt on what is the moſt touchy or moſt ſenſible teſt: of the laſt ſort I take to be the ſolutions of Silver and of Mercury ſublimate corroſive; of the firſt the ſolution of ſugar of lead, and how far our Author has obſerved this conduct I ſhall ſubmit to the reader.

Indeed if *Bath* water were what we call a ſimply ſulphureous one, ſuch as that of S. *Amande* in *Flanders*, *Nottington* in *Dorſetſhire* and divers others in *England* and *Ireland*, then undoubtedly the inference of the abſence of *Sulphur* or *Phlogiſton*, from the failure of the muddy, yellow, dark brown or black clouds upon adding the ſugar of lead, muſt have been juſt, ſince thoſe ſimpler waters do not fail to ſtrike thoſe colours with that ſolution, from the predominancy of the phlogiſtic principle acting in its full force:

But with the waters wherein there is a large proportion of heterogeneous matters the caſe is far different: Nature diſguiſes itſelf, and he that would diſcover either the ſulphureous or inflammable principle muſt expoſe the water to various trials with different materials, when he will often find one to detect what another conceals, whereas were he to truſt to a ſingle experiment of one metallic ſolution and from thence, without any regard to other metals and their ſolutions, pronounce any water to be or not to be impregnated with *Sulphur*, his concluſions would prove wild and extravagant, which in the preſent caſe has been too much, and ever will be, the conſequence of ſuch a ſuperficial examination of waters:

As an inſtance of the truth of this obſervation, I ſhall place in the front the waters of *Aken*, (confeſſedly ſulphureous) in which there is a very conſiderable mixture of calcarious Earth, *(a)* ever cauſing a white precipitation with ſugar of lead as well as with alcalis; and accordingly the *Aken* waters turn milky with the alcaline ley, and of a *muddy milky colour, and precipitate a dull white powder, with ſomething of a brown and dark aſh colour with ſugar of lead (b):* and why? becauſe the *Phlogiſton* is blended with a large proportion of terreſtrial matter precipitated by the ſugar of lead, being a precipitator in common to the white calcarious matter and to the *Phlogiſton:* to which may be added ſome particles of the Ceruſs alſo ſuffered to ſubſide, as being partly diſmiſſed by reaſon of the ſuperior attraction of the calcarious earth in the water.

(a) Eſſay on Waters, Part III. p. 84, 85. *(b)* Ib. p. 94.

And I apprehend I may not unjuſtly ſubjoin the *Bath* water as a ſecond inſtance to the ſame purpoſe, which is alſo impregnated with various minerals, and particularly a calcarious earth, manifeſted by the large white precipitate it yields by means of oil of tartar, which muſt diſguiſe the other darker coloured appearances otherwiſe to be expected in the clouds and ſediment exhibited by adding ſugar of lead to it: it is however but doing juſtice to the ſubject to bring in here the teſtimonies of others on this head from experiments made on the *Bath* water both on the ſpot and in *Dublin*; the firſt long before this controverſy was in agitation, and conſequently may be preſumed to have been impartially related, which experiments were made by Dr. *Hilary*, who found that the ſolution of ſugar of lead precipitated from the water of the *King's bath* and *Hot bath* a white powder intermixed with greyiſh ſpots, which indeed does not altogether quadrate to the *perfectly bright white clouds and lovely white magiſtery* exhibited on this mixture according to our Author, as abovementioned, but is very agreeable to the appearances exhibited by one of the artificial ſulphureous waters in the Table annexed, in which *Sulphur* is ſuſpended in conſiderable quantity, as alſo to an obſervation of my own and of another preſent on the ſame mixture, *viz.* the ſolution of ſugar of lead with the *Bath* water in *Dublin*, which in reiterated obſervations, did, on being held up to the light, beſide the whiteneſs, exhibit ſome ſhade of yellow, which, and the *greyiſh ſpots* abovementioned muſt be allowed to be as clear indications of ſome portion of *Phlogiſton* as they are in other waters, and particularly as is the *muddy milky white colour* produced by the ſolution of Lead in the condenſed vapor of *Aken* water, which we are told (*a*) moſt certainly ariſes from the *Phlogiſton*: But

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(*a*) Eſſay on Waters, Part III. p. 76.

But to ſhew how inconcluſive the meer appearance of whiteneſs exhibited by the mixture of the ſolution of ſugar of lead with regard to the non-exiſtence of *Sulphur* in waters is, I ſhall here from the labours of the indefatigable Dr. *Short*, inſtance ſeveral waters which, altho' they otherwiſe give ample tokens of their being ſulphureous, are yet ſo far from aſſuming brown or black colours with ſolution of ſugar of lead that they whiten with it, *viz.* 1ſt. the celebrated *Sulphur-well* of *Knareſborough*, *(a)* well known for its ſtrong taſte and ſmell of *Sulphur*, and which lets fall a dark ſediment. 2dly, *(b)* *Croft* water which ſmells ſtrong of *Sulphur*, and in the courſe of which every thing becomes white, with reddiſh ſpecks between, and turns of a bluiſh white with ſolution of Silver, but white with ſolution of ſugar of Lead. 3dly, *Aſkeron* water ſituated five miles from *Doncaſter*, ſmells and taſtes very ſtrong of *Sulphur*, and, as an evidence of the ſtrength of its impregnation, its ſtream is full of a white thick ſludge which ropes like decoction of Althæa, and yet with ſolution of Lead it whitens firſt, and then gives a browniſh ſediment. 4thly, *Chadlington* water ſmells like the waſhings of a foul gun, and yet turns milk white with ſolution of ſugar of Lead.

I ſhall next conſider the effects of *Bath* water on Silver and its ſolution as an evidence of the preſence or abſence of *Sulphur:* and firſt it is alledged *(c)* that a ſilver ſpoon ſtanding ſome hours in the water, and that ſilver-leaf kept therein 24 hours and the water often renewed, did not ſhew the leaſt viſible tendency to yellow, from whence it is inferred that here is no *Sulphur*.

Now, tho' the facts here related in theſe few experiments made by an itinerant viſitor be not

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(a) Short's Hiſt of min. waters, Vol. 1. *(b)* Ib. p. 299.
(c) Eſſay on Waters Part III. p. 281.

denied, yet, if I be not greatly miſtaken, this general inference is a little too haſtily drawn: for

1ſt. It had behoved an Author who was ſearching after truth, to have paid ſome regard to the experiments of others who had been longer reſident on the ſpot, and to have compared their experiments with his own; but this he has utterly omitted, and particularly that of *Guidott*, who affirms that both Silver and Braſs by a longer ſtay in the water are notably diſcoloured, even in the ſame manner as by the waters called ſulphureous, *v. g.* that Silver placed in the ſpring became firſt of a copper colour and then black, and that Silver which had lain for ſome time near the ſprings became of the ſame colour as in the decoction of *Sulphur* in Lime-water *(a)*.

2dly, In theſe complex ſubjects of philoſophic inquiry, if we would ſucceed in finding out truth, we muſt view the ſubject in a variety of lights, and conſider, not only the effects of the water, but of its Vapor, well knowing that the vapors of both putrid waters and of thoſe called ſulphureous have been obſerved to produce greater effects in tinging Silver than the waters themſelves. Accordingly our Author, when treating of *Aken* water, obſerves that Silver, in the vapor of the ſource, is almoſt inſtantly affected, acquiring a pale gold colour in leſs than a minute, and in three is carried to the higheſt degree of tarniſh *(b)*; and that poliſhed Braſs, which was kept four hours under the water, ſhewed no change, while what was above the water got firſt a pale, then a deep gold colour, and ſoon became variegated with all the ſhades of red, orange and purple: and theſe experiments are alledged as proofs of the *Phlogiſton* in *Aken* water, even as the like diſcolorations of Silver

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(a) Eng. Edit. of Treatiſe of Bath waters, Chap. 5.

(b) Eſſay on waters, Part III. p. 67.

from the vapors of putrid waters, bilge-water, *&c.* are alledged as the effects of the *Phlogiſton* in them:

But when *Bath* water comes under conſideration, not one word is mentioned as to the effect of its vapor on Silver or Braſs, whether from inattention or from a prejudice againſt this water, I ſhall not take upon me to ſay, but thus much I may adventure to affirm, that had he been as minute in his account of the *Bath* water as he had been of that of *Aken*, he would not have wanted evidence of the *Phlogiſton* in the firſt as well as the laſt. This great defect of his therefore in the compariſon of *Aken* and *Bath* waters I ſhall here endeavour to ſupply, and ſhew that the *Bath* water has as juſt a claim to an impregnating *Phlogiſton* as the *Aken* waters has, from poſitive experiments on the operation of its vapor, ſhewing that this effects in a much ſhorter ſpace of time what the water itſelf in ſome obſervations effects not at all, or at leaſt requires a much larger ſpace of time to effect:

R. Muſgrave Eſq; from *Liſmore* in *Ireland*, a gentleman of undoubted veracity, who reſided ſeveral months at *Bath* in 1752, and taking his firſt lodging in *November* in a room that had two or three large ſaſh windows ſo near the *Croſs bath*, that its ſteam hung about the *Bath* like a fog, obſerved that his Silver buckles which he put at the bottom of the window every night going to bed, became in the morning yellow like gold, which change of colour did not happen to the ſame buckles when he removed to another lodging remote from the Baths.

He alſo corroborates what is obſerved above of the offenſiveneſs of the ſteam of *Bath* waters to weak lungs by a notable example of it which fell under his own obſervation, which is alſo notoriouſly the caſe of the ſmoak of Pit-coals, as well as it's tarniſhing Silver, in both which inſtances the ſteam of *Bath* waters anſwers to that of Pit-coal, a probable indication of ſome ſimilarity in their conſtituent parts; and that Pit-coal is not a meer Bitumen, but contains alſo a ſubſtance very like common *Sulphur* and wholly diſtinct from Bitumen we may learn from ſome experiments lately made by two eminent Chymiſts *(a)*.

But to return to the effects of the vapor of *Bath* water on Silver, as this is a fact of importance, I thought it were well worth while that it ſhould be confirmed by further and repeated tryals made on the ſpot, which was accordingly done with great accuracy by a curious Gentleman of the profeſſion there, from whom I received the following circumſtantial account of this matter *July* 1761, which is here inſerted in order to ſhew that the two other hotter Baths have this power of tarniſhing Silver by their ſteam in a greater degree than the *Croſs*-Bath, *viz.*

A plate of Silver hung up in the ſteam of the King's bath, *and another in the* Hot bath, *were tarniſhed in twenty-four hours, but in forty-eight hours they were tarniſhed to a greater degree, even ſo far as to have loſt their ſplendor, and to look like* French *plate from which the ſilver is worn off: but a plate of Silver which was ſuſpended over the* Croſs bath *did not in that time at all loſe its colour, tho' it is ſuppoſed that if the Silver plate had been expoſed to the ſteam of the* Croſs bath *a longer time, it would alſo have changed its colour*; agreeably to the obſervation above related of the effects of the ſteam of that Bath on the ſilver buckles.

Now, to ſtain Silver yellow or black is the well known property of the vapors of the ſolutions of *Sulphur*, and indeed the effects deſcribed in the

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(a) Neuman's Works publiſhed by Lewis, and Shaw's philoſ. principles of univerſal Chymiſtry.

two foregoing obſervations are remarkably greater than thoſe of the vapor of the volatile vitriolic or ſulphureous Acid above mentioned, which, tho' far ſtronger and leſs diluted than the vapor of *Bath* water, did not produce this effect on Silver ſuſpended over it for a week, but required the aſſiſtance of a Sand heat to tinge the Silver.

To the foregoing obſervation agree the powerful effects of the ſteam of *Bath*-water on Iron, *viz.* it has been obſerved *(a)* that a ring of Iron has been eaten out by it in ſeven years, an effect altogether ſimilar to the well known operation of *Sulphur* on Iron, and particularly of the ſteams of the ſulphureous waters of *Aken*, as mentioned by our Author, *viz.* that *all (b) the Iron work about the Baths is greatly corroded.* Now it is well known that *Sulphur* readily unites itſelf with Iron, and turns it and Copper into yellowiſh concretes like the *Pyritæ* (*c*):

And here it ſeems to be worth while to take a ſhort view of our Author's way of reaſoning on the effects of the vapor of *Aken* water ſimilar to thoſe above related of the vapor of *Bath*-water, *viz.* In his third Section upon the *Aken* waters, having deſcribed the effects of the vapor of theſe waters on Lead, on poliſhed Braſs, Silver, *&c.* he tells us that experience *(d)* convinces us that theſe effects cannot be produced by the Acid alone, and he adds, *It muſt be then from the Phlogiſton or inflammable principle.* And a little before, *(e)* he deduces an Acid and Plogiſton in *Aken* waters from their vapors corroding Iron and Lead: and indeed this is agreeable to the foregoing experiments and obſervations on the effects of the *Bath* waters, with this explanation, that theſe effects in both waters are not owing to the meer Acid or

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(a) Method. ſynops. of min. Waters, p. 596. (*b*) Eſſay on Waters Part III. p. 64. (*c*) See Neuman. *(d)* Eſſay on Waters, Part III. p. 66, 67. (*e*) Ibid. p. 64, 65.

or meer *Phlogiſton*, but to an Union of both; for this is abundantly confirmed by the experiments related and often repeated in the Table annexed, where it appears that the volatile acid of *Sulphur*, or the acid of *Sulphur* volatilized by and combined with the *Phlogiſton* diluted with diſtilled water, has ſome effect in diſcolouring Silver in ſubſtance, tho' leſs than the ſolution of *Sulphur* in an alcaline ley, and produces the like diſcolorations with ſolution of Silver that *Bath* water does, *viz.* a dark brown ſediment and bluiſh cloud; and when this volatile acid is grown effete by the exhalation of the combined *Phlogiſton*, it effects no diſcoloration at all:

And thus is the exiſtence of the *Phlogiſton* in the *Bath* waters eſtabliſhed by our Author's experiments on thoſe of *Aken*, the like *phænomena* ariſing and the ſame reaſoning being applicable to both: and it muſt be owned that in theſe parts of his work he has done juſtice to the waters of *Aken*; but it is ſomewhat ſurprizing that he ſhould ſo far forget himſelf before he had finiſhed his book as utterly to deny the exiſtence of the *Phlogiſton* in *Bath* waters; had he reviſed his work, he muſt have ſeen that the very ſame Premiſes from which he inferred a *Phlogiſton* in the waters of *Aken* were equally concluſive with regard to a *Phlogiſton* (tho' in a leſs degree) in thoſe of *Bath*.

Having thus far ſhewn that the Vapor of *Bath* water as well as its Mud and Sand do each of them exhibit divers of the appearances proper to *Sulphur*, and that the Sand and Vapor particularly do manifeſt the union of the *Phlogiſton* and an Acid as well as *Aken* water, it will yet be neceſſary in order to clear up this ſubject from the obſcurity in which it has been involved, and to obviate an Objection that may poſſibly be made of a *Sulphur* formed in the air as in the *Aken* waters, to examine the *Bath* water itſelf from the experiments

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made on it chiefly at the fountain by our Author himſelf, tho' partly improved and in ſome meaſure corrected by others, in order that it may appear how far this Water in it's utmoſt perfection, and poſſeſſed of whatſoever is either ſublimed from it in vapor or precipitated in the form of Sand or Mud, confirms the foregoing evidences of an impregnating *Sulphur* or *Phlogiſton.*

We have ſeen above that the ſolution of Lead gives ſome faint marks of ſuch an impregnation in *Bath* water, altho' alledged for a contrary purpoſe by our Author; but this matter will be much clearer by examining the appearances exhibited by the ſolutions of other metals, as that of Silver, and of Mercury in divers forms, and of Iron in the *Engliſh* Vitriol, each of which we ſhall find to conſpire with one another as well as the Experiments above related, in ſhewing the ſame thing:

Firſt then our Author informs us that (*a*) upon adding ſolution of Silver to *Bath* water, bluiſh white clouds appear, and in eight hours a ſediment is formed of a purple hue: and (*b*) upon adding the ſame Solution to *Aken* water, firſt a milky, then a yellow, after a brown coagulation enſues, and in twelve hours it gives a white or cream coloured precipitate, and over that it is of a pale brown or dark aſh-colour.

Now in the account given by our Author of the *Aken* water, theſe and the like diſcolorations by means of ſolution of Silver are attributed to the *Phlogiſton*, nay, even ſo weak a tincture as that of Moſel wine produced by ſolution of Silver in the condenſed vapor of *Aken* water is attributed to the *Phlogiſton* (*c*); and indeed theſe diſcolorations by this ſolution do exactly anſwer to the effects of the ſame ſolution on that of *Sulphur*, the colours

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(*a*) Eſſay on Waters, Part. III. p. 305. (*b*) Ib. p. 95, 96.
(*c*) Ibid. p. 76.

being varied to yellow, brown or black according to the different ſtrengths of the ſolutions of *Sulphur*: and in the *Bath* water the ſediment is of a purple hue: thus, as in many other experiments, the ſolution of Silver is found to be a much more ſenſible teſt of the preſence of the *Phlogiſton* than ſugar of Lead, as further appears by comparing their effects on the putrid waters in the Table annexed.

Why then does not our Author conſider theſe appearances in *Bath* water from ſolution of Silver as evidences of the *Phlogiſton* as well as in the *Aken* water?

Let us next ſee how agreeable the above appearances from ſolution of Silver are to thoſe exhibited by other metallic ſolutions, and firſt by that of Mercury in different forms: The *Aqua Sulphurata* in the Table, upon the admixture of the ſolution of Mercury in *Aqua fortis* gave a fleſh coloured precipitate and a pale blue purpliſh circle, and in the ſame water become ſomewhat effete by keeping, the mixture was yellow:

But it will be cloſer to the purpoſe to conſider the effects of Mercury on the *Aken* and *Bath* waters, and to give the etiology of the appearances as laid down by the Author, thus: The ſolution of Mercury ſublimate in diſtilled water produces in *Aken* a pellicule variegated with all the colours, and the ſame ſolution he tells us (*a*) alſo exhibits a pellicule of all colours in *Bath* water (*b*), to which let me add that I alſo obſerved the very ſame appearance on the mixture of the ſame ſolution with *Bath* water in *Dublin*, which had been taken up many months. Now how is this appearance explained? In the waters of *Aken* (*c*) our Author ſolves it in theſe words:

(*a*) Eſſay on Waters, Part III. p. 94. (*b*) Ib. p. 303.
(*c*) Ib. p. 99.

"*The Phlogiſton ſhews itſelf in the pellicule, that ſubtile principle, from different combinations of which all colours as well as odors ariſe?*" And why not in *Bath* water as well as *Aken?* The partiality or precipitancy of ſuch a writer is too obvious:

I ſhall conclude with the appearances exhited by the mixture of green Vitriol with the *Bath* water, our Author's relation of which I ſtrongly ſuſpect may require a reviſal; for he tells us (*a*) that the ſolution of green Vitriol in diſtilled water cauſed milky clouds with a pale yellowiſh hue, which ſubſide in the form of an ochreous precipitate. Here he ſays not one word of any variegated pellicule (which would have been as good an evidence of *Phlogiſton* as that from the Sublimate above in *Aken* water) whereas I do affirm that, agreeably to the account given elſewhere, (*b*) in ſome *Bath* water which had been kept ſeveral months in *Dublin*, the ſolution of green Vitriol in diſtilled water exhibited a variegated Scum conſiſting of the red, yellow and blue colours; and laſt ſummer 1761, a ſolution of Sal Martis in diſtilled water being mixed with the *King's bath* water on the ſpot, the reſult obſerved by the ſame curious Gentleman of the Profeſſion abovementioned, was, that a pellicule was formed of a beautiful, vivid, blue and gold colour, like the *Cauda pavonis*, or like what we often ſee in ſtagnant waters near Coal-pits.

And the ſame Gentleman in a ſubſequent Letter aſſures me, that the precipitate made from *Bath*-water by ſugar of Lead, becomes *greyiſh* by ſtanding, which confirms Dr. *Hilary*'s experiment above mentioned, and invalidates the evidence from the *lovely white magiſtery* ſaid to be exhibited by the ſame mixture above, being the cardinal experiment

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(*a*) Eſſay on Waters, Part III. p. 307.
(*b*) Method ſynops. of min. Waters.

ment of our Author from which he thought himſelf authorized utterly to explode any *Phlogiſton* from theſe waters, but how juſtly is now ſubmitted to the reader.

And now, to ſum up in one view the Experiments above related on the Mud, Sand, Vapor and Water of *Bath*, in order to ſee how far they are evidences of an impregnating Sulphur,

1ſt. The Mud of *Bath* water, or the Earth tinged by a ſmall quantity of a matter which is a *pabulum ignis*, agrees to the Mud of *Aken* and other ſulphureous waters, and to the analyſis of *Sulphur* in the colour, and agrees to *Sulphur* in the ſmell and in diſcolouring Silver.

2. The *Bath*-Sand agrees to *Sulphur* in it's ſmell and in it's appearances in the fire.

3. The Vapor of *Bath* water produces the like effects as that of ſolution of *Sulphur* in tarniſhing Silver, tho' in a leſs degree; alſo it agrees to *Sulphur* in corroding Iron.

4. The Water itſelf exhibits with the metallic ſolutions the like diſcolorations as ſolution of *Sulphur* does with the ſame ſolutions.

Thus both the Water itſelf and what is precipitated from it conſpire in exhibiting appearances proper to *Sulphur*, and ſome of them peculiar to it, and the defect of evidence in one experiment is abundantly compenſated by the light afforded by others, upon a careful review of the whole.

It is true, the *Aken* waters give proofs of a ſtronger impregnation by the above trials, as well as yield flowers of *Sulphur*, which the *Bath* waters do not; and the firſt ſmell much ſtronger, and like a ſolution of the *Hepar ſulphuris*, containing the mineral Alcali, of which the *Bath* waters do not partake, their Salts being of a neutral kind, whereas in thoſe of *Aken* the Alcali, (a fit menſtruum for diſſolving *Sulphur)* prevails; and yet it has been ſhewn above that not only Nature, but Art, can effect a ſolution of *Sulphur* or keep it ſuſpended in an inviſible ſtate in water without an Alcali: and indeed the volatile ſulphureous Acid diluted produces diſcolorations with ſolution of Silver like what are produced by ſolution of *Sulphur*, tho' in a leſs degree, and nearly like what *Bath* water exhibits with the ſame ſolution.

Bath water indeed has not, as far as I have learnt, exhibited a diſtinct palpable *Sulphur*, nor is this to be wondered at, becauſe, exiſting in very ſmall *moleculæ*, and thoſe blended in large quantities of other materials, it is diſſipated and loſt in the proceſs; for this alſo is the caſe of moſt of thoſe waters which otherwiſe give undoubted proofs of an impregnating Sulphur and yet elude almoſt every attempt to collect it, excepting in that white glairy matter which is ordinarily depoſited by theſe waters, from which an evident *flos ſulphuris* in two different waters was obtained, as is related in the foregoing ſection.

We may therefore now be enabled to ſtate the Compariſon between the waters of *Aken* and thoſe of *Bath* thus:

1. They are both confeſſedly impregnated with the *Pyrites*, of which we are aſſured there is great plenty in the neighbourhood of *Bath* as well as *Aken*.

2. They both betray *Sulphur*, but in different manners and in different degrees: *Aken* by the ſmell like ſolution of *Sulphur* in an alcaline ley, whilſt that of the *Bath* is rather like the *Gas ſulphuris* or volatile ſulphureous Acid diluted; and accordingly the firſt is of a ſaponaceous quality, and its impregnating ſalt reſembles the *Soda*, the laſt is a hard water and manifeſts a degree of acidity ſo far as to curdle Milk, its ſaline contents being marine ſalt and calcarious Nitre; and yet

there is one peculiar character and recommendation due to the *Bath* water from the infallible teſtimony of our taſte, *viz.* a milky ſoftneſs owing probably to an impregnating bituminous matter enveloping the ſalts which makes it ſit eaſy on the ſtomach and bowels, and renders it a good volatile for other medicines, being free from the nauſeouſneſs of *Aken* waters.

Again, in *Aken* water the flowers of *Sulphur* are collected in the vaults of the ſources of ſeveral of the Baths: in the *Bath* water the *Sulphur* is moſt manifeſt in the Sand, being a compoſition of *Sulphur*, Iron and calcarious Earth.

The volatile ſulphureous Acid is common to them both, conſiſting of an union of the Acid and *Phlogiſton* in the vapors of both, which have the like effects in corroding Iron, and in tarniſhing Silver, tho' this laſt appearance is much ſtronger in the *Aken* than *Bath* waters; but both waters have in a great meaſure ſimilar effects on the ſolutions of Silver, Mercury and green Vitriol.

3. The *Bath* water therefore maintains its title to the powerful effects aſcribed to it, not meerly from actual heat, nor meerly from the ingredients common to it and any meer purging Chalybeate water heated, but alſo from a ſulphureous impregnation, and particularly as an expeller of gouty or other morbid humors to the ſurface of the body.

SECTION V.

Of the Briſtol *water, it's character as a Calcarious one aſſerted, to which the* Phlogiſton *is ſuperadded, with the Compariſon of this and the* Bath *water.*

HAVING ſo far heard our Author on the *Bath* water, let us now attend him a little while on that of *Briſtol*, which we have hitherto been told is a native Lime-water, of an abſorbent, ſweetening and gently reſtringent quality, and uſeful in common with the *Buxton* and other warm Calcarious waters in the diabetes, hectics, internal ulcerations, in moderating exceſſive diſcharges of the blood or humors, in ſome ſtubborn Colics and other diſorders of the primæ viæ, and that it is uſeful for theſe purpoſes, not only at the fountain, but when tranſported to remote places, and at leaſt greatly preferable to common water.

But as it has been above obſerved of our Author in relation to the exiſtence of *Sulphur* in waters, that his ſuperior genius has carried him into refinements far beyond the evidence of common ſenſe, it may with no leſs truth be affirmed that he has taken care to maintain an uniformity of conduct in relation to the exiſtence of the Calcarious matter, at leaſt in the *Briſtol* water, and that he is equally paradoxical as to both theſe waters; for, altho' the *Briſtol* water be remarkable for *imprinting the moſt* (*a*) *ſoft and grateful ſenſation upon the palate*, and for exhibiting a *plain and evident appearance of ebullition with all acids vegetable as well as* (*b*) *mineral*, and for *depoſiting a chalk-like* (*c*) *matter upon the bottom and ſides of the tea-kettles in which it has been often boiled*; yet in the ſequel (*d*) it is queried, *Why are theſe waters ſingled out as Calcarious, moſt waters having an equal, many a ſuperior titule to that appellation*; but that it's good effects are chiefly to be aſcribed to a *ſubtile*, (*e*) *volatile, acid ſpirit*, which *it greatly loſes in the carriage*, and conſequently the exportation of this water ſhould be of little uſe; but that *where a water of this particular temperature (f) may not, as in ſome delicate habits it muſt, be neceſſary, in all intentions* to

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(*a*) Eſſay on Waters, Part III. p. 354. (*b*) Ibid. p. 359. (*c*) Ibid. p. 361. (*d*) Ib. p. 366. (*e*) Ib. p. 367. (*f*) Ib. p. 367, 368.

to be anſwered by the Hot-well water, ſuch as hectics, diabetes, &c. he ſhould prefer the ſimple, neglected ſpring called the Mill-ſpring, in its neighbourhood, diſtinguiſhed chiefly by its *exceſſive coldneſs, greater* (*a*) *ſparkling and diſcharging a greater quantity of air-bubbles.* But,

Is not this to ſubſtitute meer ſpeculation to ſolid obſervation and experience, the only ſure teſts of the effects of any medicine, and is it not an inſtance of raſhneſs and preſumption to recommend a new ſpring, whoſe effects any other than are common to ſimple water we are wholly unacquainted with from obſervation, in preference to the old Hot-well, whoſe virtues are long eſtabliſhed by experience and which is actually found uſeful and greatly preferable to common water for the purpoſes above mentioned, and even upon it's tranſportation to *Dublin*, where it has long been and continues to be ſucceſsfully preſcribed in conjunction with other ſweetening and reſtorative medicines?

I ſhall therefore, from a conviction of the real uſefulneſs of this water, endeavour to vindicate it's character; and to reſcue the ſubject of its real mineral contents from the darkneſs and perplexity in which he has left it; and in order to this ſhall minutely conſider the chief diſcoveries our Author ſeems to think he has made, which may be reduced to three Paradoxes:

The firſt is, that the good effects of this water are to be aſcribed chiefly to a volatile acid Spirit: to which I anſwer

That the univerſal or vitriolic Acid enters into the compoſition of moſt or all mineral waters I grant him; but what I oppoſe is, that an acid Spirit either volatile or fixed ſhould be conſidered as a principal ingredient in the *Briſtol* water, and that on which it's chief energy is to be reſted, for 1ſt.

K Expe-

(*b*) **Eſſay on waters, Part III. p. 354.**

Experience is againſt him, with reſpect to the real good effects of this water at a diſtance from the fountain, as has been above obſerved. 2dly, It is certain that *Briſtol* water gives far leſs evidences of an Acid, and wants thoſe evidences of an Acid which are exhibited by the other waters he has treated of, particularly thoſe of *Aken*, *Bath* and the purging waters, as will appear to any one upon the peruſal and compariſon of his own account of theſe waters; and tho' it were to be expected that one who ſets out with an utter contempt of the Opinions of others, ſhould eſtabliſh his own by ſolid and concluſive experiments, he is ſo far from anſwering ſuch reaſonable expectations, that the Experiments he has offered having any tendency to eſtabliſh an Acid in *Briſtol* water, will be found to be partly extremely ſlender, and partly equivocal and inconcluſive: for

The firſt experiment of this tendency is, that the Hot-well water *being diſtilled in (a) a high bolted retort, in ſand, placing a piece of blue paper in the juncture, this was ſlightly faded to a purpliſh:* A ſlight evidence of an Acid indeed, at leaſt a very ſlight one of a predominating Acid, and no more than what Rain water and other common waters by his own experiments on thoſe at Spa (*b*) affords, to which I might add alſo than Rain water and other waters alſo (*c*) in other places give.

The ſecond Experiment he mentions that has any tendency to prove an Acid in *Briſtol* water, will be found to be abſolutely inconcluſive by other Experiments, and even by his own teſtimony, *viz.*

The *Hot-well water with the dry (d) alcaline Salts cauſed a quick and ſtrong ebullition, and the Mill-*

(*a*) Eſſay on Waters, Part III. p. 362. (*b*) Ib. Part II. p. 119. (*c*) Method. ſynops. of min. Waters, p. 36. (*d*) Eſſay on Waters Part III. p. 358.

ſpring cauſed a ſtronger ebullition, eſpecially with the dry volatile Alcali:

Here our Author had certainly forgotten what he had told us in the foregoing part of his work, *viz.* that *the dry alcaline ſalts* (*a*) *cauſe a ſmart ebullition*, even *when thrown into diſtilled water*, and likewiſe the prudent caution he had given, *not to* (*b*) *reſt too much upon the ebullition* enſuing *on the mixture of dry alcali's as a deciſive proof of an Acid in waters*; ſo that the ebullition of *Briſtol* water with the dry Alcali's is no more a proof of an Acid in that water than in diſtilled water, and may be better accounted for from the Air with which, according to late obſervations (*c*) the dry volatile alcali is always replete and which parting with ſome of it's air in the ſolution adds to the air with which the water itſelf is alſo replete, and eſpecially the *Mill-ſpring*, and ſo puts on the appearance of a ſtrong ebullition.

On the contrary I ſhall ſhew from the evidence of our Author's own experiments that, whatever ſhare may be allowed to an Acid as a menſtruum diſſolving the terreſtrial matter in *Briſtol* water, it becomes ſo far neutralized, that the whole compoſition, the water, examined at the fountain, manifeſts a predominant Alcali; for 1. *It gives a plain and evident appearance of an ebullition with all the Acids vegetable as well* (*d*) *as mineral.* 2. *With Syrup of Violets it ſtrikes*, not a roſe-purple as the *Pouhon* and *Geronſterre* waters, but a ſea-green, gradually hightening to a graſs-green (*e*). 3. It *produces an orange or bright amber colour with infuſion of Rhubarb, and a pale roſe purple with infuſion of Cochinelle* (*f*), arguments of an alcali (*g*). 4. It depo-

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(*a*) Eſſay on Waters, Part II. p. 108. (*b*) Ib. Part III. p. 85. (*c*) Dr. Black's Experiments in Med. Eſſays and Obſervations, Vol. II. (*d*) Eſſay on Waters, Part III. p. 359. (*e*) Ib. p. 355. (*f*) Ib. p. 357. (*g*) Ib. p. 80, and 84.

depoſites a terrene chalk-like (*a*) matter fermenting ſtrongly with acids: from all which abundantly appears the vanity of our Author's endeavours to ſet up an Acid in the *Briſtol* water as the chief ſeat of it's virtues.

I proceed next to conſider whether his ſecond Paradox concerning this water be any better founded, *viz. that it is not ſimply calcarious, moſt waters having an equal, many a ſuperior titule to this appellation* (*b*).

He profeſſes to be very exact in his analyſis of the terrene contents of this water, and in his calculation of the different ingredients of thoſe contents, and from thence pronounces near one half, *viz.* 2¼ grains out of 5 to be fair, diſtinct, inſoluble ſelenite.

Now as the Selenite is a foſſil of great uſe to our Author, and which he adopts by wholeſale, and by means of it fills up many chaſms through the whole courſe of his work, it may be of uſe to obſerve that his determination of it's preſence in any water is far from being clear, *viz.* that what is commonly called the terrene matter and left in the filtre after the ſeparation of the ſalts from it, ſo much of it as conſiſts of minute, ſhining *laminæ* or *flakes*, is *inſoluble* in *water* and *acids*, and *unalterable in the fire is* a (*c*) *Selenite:*

But certainly, a little more preciſion and ſome little regard to the definitions given of this foſſil and its diſtinguiſhing marks by authors of eſtabliſhed reputation had been more conſiſtent with his character as a reformer of our language; one of which marks are, that the Selenite is ſo far from being unalterable by the fire, that it is calcinable and reduced to a plaiſter by being burnt,

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(*a*) Eſſay on Waters, Part III. p. 361. (*b*) Ib. p. 366.
(*c*) See Part II. p. 170, and 230.

and by this criterion it is diſtinguiſhed from the ſtones called Apyri, as the Talcs, Mica, *&c.* (*a*) which are neither fuſible nor calcinable in the fire, and moreover reſiſt acids as well as the fire; ſo that our Author's deſcription of the Selenite agrees rather to ſome ſpecies of the Talc, Mica or whatſoever of the Lapides Apyri ſhall be determined by more minute experiments, and not to the Selenite of other Authors, nor to the inſoluble matter in *Briſtol* water, which loſes near one half of it's weight in the fire, as other calcarious earths do, and the Magneſia rather more than half, and according to ſome late obſervations what is loſt by the fire conſiſts in a great meaſure of air, which is one characteriſtic by which calcarious ſtones and earths are diſtinguiſhed from Mill-ſtones, Flint, Talc, *&c.* and Dr. *Lucas*'s *Selenite*, which is pronounced unalterable by the fire, and like the others juſt now mentioned manfeſts no air by any fermentation with acids; and were there no other argument of the inſoluble matter of *Briſtol* water being principally a Calcarious earth, this mark of it alone, *viz.* it's yielding as great a quantity of air as the calcarious earths do by the fire and by fermentation with acids, might ſuffice, and withal to ſhew that did it conſiſt of near one half of what our Author calls Selenite, it ought not to exhibit ſo great a quantity of air either by the fire or by fermentation with acids, as the pure calcarious earths, which yet it is found to do.

I have however been at the pains to repeat thoſe experiments which have induced our Author to attribute to the *Briſtol* water ſo large a proportion of the Selenite as he does, and to endeavour to deprive it of the appellation of Calcarious hitherto given it by general conſent.

(*a*) *Hill*'s Hiſtory of Foſſils, and *Walerius*'s Mineralogie.

On ten grains of the grey terrene matter of the *Briſtol* water left in the filtring paper after the ſeparation of the ſaline by diſtilled water, I poured Spirit of Salt until it was entirely ſaturated; then waſhing with diſtilled water and exhaling to dryneſs, there was left only two grains and a half, *i. e.* $\frac{1}{4}$th of the whole undiſſolved by the Spirit of Salt, which undiſſolved part was chiefly, not a ſhining, but brown matter, exhibiting even when viewed in the ſun-ſhine, only a few ſhining ſpangles and when put into an ignited crucible, it ſparkled and loſt above half of its weight, leaving only one grain bare weight of what was not conſumed by the fire nor diſſolved by Spirit of Salt, (which alſo exhibited very little of the ſhining ſpangles,) *viz.* only $\frac{1}{10}$th of the whole, ſo that, of ten grains of the terrene matter here are nine diſſolved in Spirit of Salt and conſumed in the fire.

I query then, where is the *fair and diſtinct inſoluble Selenite* of our Author conſtituting, according to him, near one half of the terrene matter?

I made the like experiment with another parcel of the terrene matter and *Aqua fortis*, and there was left only one ſeventh part undiſſolved, being a dark brown powder, which in the ignited crucible loſt near half of its weight, ſo that here was only $\frac{1}{14}$th part of the terrene matter left undiſſolved by the *Aqua fortis* and not conſumed by the fire: thus in both theſe experiments one half of what is left undiſſolved by the Acids is conſumed in the fire, and conſequently this one half is not the *Selenite* of our Author which he ever pronounces to be unalterable by the fire; but this he forgets to make allowances for in his calculation, which aſſuredly ought to be done, it being a conſiderable part of what conſtitutes the inſoluble matter called terrene, and conſequently ſo much at leaſt ought to be ſubtracted from the large proportion of Selenite he would introduce into the *Briſtol water.*

I alſo examined the white Chalk-like matter depoſited in the tea-kettles uſed in boiling the Hot-well water, being a more purely terreſtrial matter with little or no mixture of the phlogiſtic, and found it to be almoſt wholly diſſolved in *Aqua fortis*, (the matter left undiſſolved being altogether inconſiderable) the genuine character of Spar and Calcarious earths, by which they are diſtinguiſhed from the *Selenite*, which always remains untouched by Acids.

I alſo varied the experiment on the inſoluble matter thus, in order to compare it to ordinary Lime-ſtone: I put three different parcels of it into a red hot crucible, and on a red hot iron: it ſmellt ſulphureous and loſt near one half of it's weight, as ordinary Lime-ſtone does, the remainder was Lime, which had a few ſhining particles interſperſed being a *Selenite* of our Author, but not of others according to whom the Selenite is ever calcinable and becomes opaque by the fire, whereas the *Mica* or *Talc* reſiſts both the fire and acids. And indeed it is no new thing to find ſome particles of the *Mica* interſperſed with the calcarious matter in Lime-ſtone, even as in the above-mentioned reſiduum of *Briſtol* water, *v. g.* in the *Lapis Calcarius particulis ſcintillantibus* ſpecified in *Walerius* his Mineralogie, but in no wiſe in ſuch quantity as to deſtroy the character or appellation of Lime-ſtone; from all which I conclude, that the introducing the Selenite as an ingredient of conſequence in the Hot-well water is an affected novelty deſtitute of ſupport from experiment.

It is therefore aſtoniſhing that our Author ſhould not only query, (*a*) *why are theſe waters ſingled out*

(*a*) Eſſay on Waters, Part III. p. 366.

as calcarious more than any others? but even take upon him to aſſert that *moſt waters have an equal, many a ſuperior titule to the appellation of* Calcarious?

And indeed this implies ſuch an utter unacquaintance with the diſtinguiſhing contents of waters, that I ſhould chuſe to paſs it by in ſilence, except on this account, that it may give opportunity for making ſome obſervations concerning the different Earths of different Waters, and the rather, as ſome recent inquiries have enabled us to give a more clear and diſtinct account of this matter.

To the query then I anſwer, that the *Briſtol* water is not ſingled out as Calcarious, but rather joined to others ſimilarly impregnated, particularly the warm waters in *Derbyſhire*, to which they agree in their ſituation among great rocks of Lime-ſtone, in the calcarious quality of the terreſtrial matter obtained from them by evaporation, and in this, that the terreſtrial matter in them predominates in quantity over the ſaline, which, according to *Liſter*'s obſervation, gives a reſtringent quality, common to theſe waters, which are alſo found to have the like virtues in exceſſive profuſions of the blood and humors, in the Diabetes, *&c.*

Next, as to his aſſertion, that *moſt waters have* an *equal*, many *a ſuperior title to the appellation* of *calcarious*, I deny it; and on the contrary affirm that few have an equal, much leſs a ſuperior title to this appellation: for 1ſt. Even in the Petrifying waters whoſe terreſtrial contents are alſo generally of the calcarious kind, the contents obtained by evaporation from ſeveral of them does not exceed, and from others falls ſhort of the quantity of calcarious matter obtained from *Briſtol* water. 2dly, Our ordinary ſoft waters, ſuch as the *Thames*, *&c.* are far from having an equal title to this appellation; for theſe do not make an ebullition with Acids equal to what the *Briſtol* water does, and moſt of them none at all, nor do they exhibit half, commonly much leſs than half the quantity of ſolid contents that *Briſtol* water does, and thoſe not of the white or chalky appearance, as the *Briſtol* water, but brown or grey, from an heterogeneous matter mixed with the calcarious. 3dly, Our common hard waters differ ſtill more widely from the *Briſtol* water, even in the ſaline matter in them uſually predominating over the terreſtrial (the reverſe of what obtains in *Briſtol* waters) which gives them a degree of acrimony and a laxative quality if they are taken in large quantities. 4thly, Our ordinary Chalybeate waters generally yield a far leſs quantity of terreſtrial contents than the *Briſtol* water, and thoſe conſiſting of an ochreous matter blended with the calcarious. 5thly, The Vitriolic waters, ſuch as *Shadwell*, *Hartfell*, *Killbrew*, *&c.* exhibit a purely metallic or ochreous Earth ſpecifically different from that of *Briſtol*, *Buxton* and *Mallow*. Laſtly, I have found in many of the purging waters, particularly thoſe of the bitter kind, which by mutual conſent we pronounce impregnated with *Liſter*'s *Nitrum calcarium*, that the terreſtrial matter differs greatly from that of the *Briſtol* water; for it very often failed more or leſs in the two eſſential characters of calcarious earth, *viz.* fermenting with acids and being reduced to Lime by calcination: for in ſeveral of theſe waters the inſoluble matter either fermented but little, or not at all with Acids, and in ſome of them it acquired but little, and in others nothing at all of the acrimony of Lime by calcination; ſo that the inſoluble matter of theſe waters appears to be either of the mixt kind, or but partly calcarious, and partly of the ſelenitical, gypſeous, talcous or other kind to be more accurately determined by further obſervation; in the mean time we may probably conjecture that ſuch concretes may be formed by the calcarious matter abſorbing the vitriolic Acid, with a large ſhare of which laſt theſe waters are undoubtedly impregnated, as appears from their curdling Milk, precipitating a groſs white ſediment with alcali's and a yellow one like Turpeth mineral with the ſolution of Mercury in ſpirit of Nitre, for which laſt evidence of the vitriolic acid they are peculiarly remarkable (*a*).

I proceed next to our Author's third Paradox in relation to the *Briſtol* water, even his giving the preference to what he calls the *Mill-ſpring* to the *Hot-well:* Let us hear his elogium on this his favorite ſpring:

" *I found this ſpring* (*b*) *demand mine attention ſo much at the firſt ſight of it, that I gave it a very full examination: and as I know not its equal in* Britain, *I think it of importance enough to be made known, as I am perſuaded it muſt ſerve many excellent medecinal purpoſes as well as the only one to which it is now applied, that of a cold Bath— taken up in a glaſs it ſparkles nearly equal to that of* Pouhon *at* Spa, *and like that, covers the glaſs with bright air-bubbles—it greatly outdoes the Hot-well in ſparkling more quickly, and greatly, and depoſiting a much greater quantity of the brighteſt air-bubbles in the glaſs.*"

But, what are the real operation and effects of this water from experience? We have no account of any; and as to the mineral contents, it aſſuredly has far leſs than the Hot-well water, ſo that the preference he has taken upon him to give to his favorite ſpring has literally no better a foundation than a bubble of air, of which a puerile fondneſs ſeems to betray itſelf in the above *elogium*, which it's pity he ſhould ſo far indulge as to dictate it's

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(*a*) See Neuman's Works with Lewis's notes on Gypſum.

(*b*) Eſſay on Waters, Part III. p. 352.

uſe in practice and recommend it as fit for tranſportation. I apprehend it had been more ſuitable to the dignity of his character as an Adept to have diſcountenanced the vulgar error of admiring any water for the quantity of air-bubbles it contains, and the rather, as it appears from other parts of his work that he was not ignorant of the real diſtinction that there is between elaſtic air and the mineral acid Spirit, *v. g.* "*The Tonnelet water ſpoiled* (*a*) *of all it's elaſtic air and ſpirit by agitation on the air-pump, ſtill ſhews ſome ſtrong appearance of purple* (a mark of acidity) *with Syrup of Violets.*" And agreeable to this are other obſervations, that a water may be deprived of it's elaſtic air by agitation and exploſion whilſt the minerals, *v. g.* Iron and Sulphur are kept inviſibly ſuſpended as before; and on the other hand, it is well known that there are ſeveral waters which exhibit no veſtiges of either acid or other mineral contents, and yet abound with air-bubbles; nor is it leſs certain that waters of the greateſt eminence for their virtues from experience are remarkable for containing leſs air, *v. g.* the celebrated Chalybeate of *Dunſe* in *Scotland*, on which the ingenious Dr. *Home* lately publiſhed an Eſſay, who obſerves that "*it ſparkles a little in the glaſs and emits a few air-bubbles*;" but (he proceeds) "*this is of little or no uſe to the water, but on the contrary the* Dunſe *water is the better for having but little air: for the hiſtory of ſuch waters as contain much air ſhews their ill effects on the primæ viæ, viz. eructations, pains, ſwellings, and ſpaſms, whence, to prevent theſe effects, hot carminatives are taken along with them.*" And it may be further obſerved as an argument of an impregnating volatile ſulphureous acid altogether diſtinct from air, that the *Dunſe* water, tho' it contains but

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(*a*) Eſſay on Waters, Part. II. p. 202.

little air, yet it raiſes the ſpirits and produces a temporary drunkenneſs.

To this add our Author's own account of the famous *Pouhon* water (which has long ſtood the teſt of experience for it's ſuperior uſefulneſs and excellency) ſhewing that the ſparkling quality of that water in what is imported to us, for which ſome inconſiderate perſons admire it, is in a great meaſure acquired by bottling: for he aſſures us that, *when* (a) *lifted out of the well in a water glaſs, it does not appear to ſparkle, altho' upon ſtanding it covers the inſide of the glaſs with ſmall air-bubbles.* The *Geronſterre* alſo contains far leſs of theſe than the *Tonnelet* water, and yet the *Geronſterre* and *Pouhon* waters not only yield a much greater quantity of mineral contents, but are the waters of the greateſt reputation for their virtues as found by obſervation.

It is true our Author, ever determined not to ſubmit to vulgar traditions, upon obſerving the ſuperior ſparkling quality of the *Tonnelet* water, altho' it has no *perceptible* (b) *ſmell, and little if any of the vitriolic or ferrugineous taſte which the others have, nor ever fouls its baſon, nor cauſes offenſive belches as the others do,* takes upon him to give it the preference to the other more frequented and much more ſtrongly impregnated wells; and I am aſſured from very good authority that an attempt was lately made at *Spa* to induce ſome of the invalids there to forſake the old wells and make tryal of a newly recommended ſparkling water, but that the event did not anſwer their expectations; for the new well was found not to agree with them ſo well as the old.

So much may ſuffice to ſhew the danger of indulging ſpeculation, without due ſupport from experience in the recommendation of any water; and with me it is more than probable that, if the compariſon were to be made between the real effects on the body of the old *Hot-well* and the *Mill-ſpring*, the former would abundantly ſupport it's credit in preference to the other more ſparkling, but leſs impregnated water, not only from it's warmth, but from it's peculiar ſoftneſs and higher degree of impregnation with minerals of an ant-acid, ſweetening, cooling quality, beſides another ingredient, to which I now haſten to give ſome account.

(a) Eſſay on Waters, Part II. p. 147. (b) Ibid. Part II. p. 198, 199.

Our Author having to the utmoſt of his power endeavoured to diveſt the *Bath* water of the *Phlogiſton*, does not ſeem to have once dreamt of a *Phlogiſton* in *Briſtol* water, of which however that it is really poſſeſſed I ſhall ſhew to be the conſequence of his own experiments confirmed and illuſtrated by other obſervations.

1. Doctor *Short* had long ſince obſerved concerning the warm waters of *Buxton* and it's neighbourhood (which in the mineral contents agree very nearly to the *Briſtol* water) that they produced ſuch diſcolorations with the metallic ſolutions as indicated an impregnation with at leaſt ſome ſteam or vapor of *Sulphur*, or ſome phlogſtic matter in the language of our Author, who alſo grants and even contends for a volatile Acid in *Briſtol* water; and if this be the ſulphureous or vitrolic acid volatilized by the *Phlogiſton*, or if it be accompanied by the *Phlogiſton*, then *Briſtol* water ſhould contain the principles of *Sulphur* as well as the *Aken* waters do: and the preſence of ſuch a volatile ſulphureous acid in the *Briſtol* water may alſo perhaps be confirmed by an obſervation of one of it's effects in the body, and particularly in affecting the brain: for it is not peculiar to the Chalybeate waters to affect the brain in thoſe who

firſt begin to drink them, in cauſing a ſleepineſs or giddineſs like drunkenneſs, but it alſo appears by later obſervations that ſome degree of a like effect is produced by the warm Calcarious waters, and particularly thoſe of *Buxton*, which (*a*) affect the head with a kind of inebriating giddineſs, and it is alſo obſerved that the *Briſtol* water drank on the ſpot is apt on it's firſt uſe to create (*b*) uneaſineſſes in the head; and altho' our *Mallow* water be conſiderably inferior in heat to either of the two laſt mentioned warm waters, yet I find, upon enquiry from two phyſicians of credit in that neighbourhood, that it alſo has not unfrequently ſimilar effects on ſome of the invalids, particularly in producing a heavineſs in the head on the firſt four or five days after drinking it, but moreover

2. The ſituation of the *Briſtol* water in the neighbourhood of large rocks of Lime-ſtone, and thoſe rocks, as is particularly obſerved by our Author, (*c*) *being moſtly compoſed of a kind of ſolid blue Marble, which yields ſomething of a ſulphureous ſmell upon friction*, favours an impregnation with a phlogiſtic matter: and this argument receives an additional weight from ſome late obſervations tending to ſhew that the colours of Marble and other ſtones are owing to ſulphureous or bituminous vapors. See *Walerius*'s Mineralogie and the *French Memoirs*.

3. The *pearl opacity* which the Hot-well water gives with the *ſolution of lead in diſtilled vinegar*, the *pellicle variegated with all the colours* it gives with the *ſolution of corroſive ſublimate*, the *dark purple coloured cloud and precipitate tending to blue* with *ſolution of Silver*, to which let me add, (what our Author has omitted as a concurring evidence

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(*a*) Treatiſe of the nature and virtues of the *Buxton* waters.

(*b*) Method ſynops. of min. Waters, p. 617.

(*c*) Eſſay on Waters, Part III. p. 394.

of the ſame thing, *viz.*) a variegated pellicle alſo obſervable in this water imported into *Dublin*, from the admixture of *Engliſh* Vitriol, as in the Table annexed: I ſay theſe dark-coloured clouds, precipitates and variegated pellicles, which alſo, or at leaſt moſt of them, appear in the waters of *Aken*, upon the ſeveral mixtures of the ſame ſolutions with them, are by our Author not unjuſtly attributed in *Aken* (*a*) water to the Phlogiſton, *from the different modifications and combinations of which all colours as well as odors ariſe.* But why then does he not pay the ſame complement to the *Bath* and *Briſtol* water? even from their altogether ſimilar appearances with the ſame metallic ſolutions as in the *Aken* water, but on the contrary utterly deny the exiſtence of the *Phlogiſton* in *Bath* water and ſuppreſs the leaſt mention of it in the *Briſtol?*

4. A ſhort compariſon of the phænomena exexhibited by the *Hot-well* water and by the *Mill-ſpring* will at once ſhew the peculiar, ſuperior impregnation of the *Hot-well* with the *Phlogiſton*, and the vanity of his endeavours to ſet up that water in preference to this.

How much more of the white terrene matter the *Hot-well* water affords than the *Mill-ſpring* he has taken care to inform us, (*b*) *viz.* as 26¼th to 15, and from other experiments of his compared with my own it will appear alſo to contain a proportionably greater quantity of *Phlogiſton:* for our Author obſerves (*c*) that *the* Hot-well *with ſolution of Silver gives a purple precipitate tending to a blue*, but *the* Mill-ſpring *a paler precipitate and later formed* with the ſame ſolution; I alſo repeated theſe experiments on the *Hot-well* and *Mill-ſpring* carefully bottled and tranſmitted to me in *Dublin*, and found that, notwithſtanding our Author diſcourages

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(*a*) Eſſay on Waters, Part III. p. 76, 99, 100, 101. (*b*) Ib. p. 363. (*c*) Ib. p. 361.

the tranſportation of the firſt and recommends that of the laſt, that the laſt on tranſportation exhibited a much paler precipitate with ſolution of Silver than the firſt, which by the darker colour of the precipitate ſhewed a ſtronger impregnation with the *Phlogiſton*.

Again, (*a*) the *ſolution of Mercury in Spirit of Nitre* gives with *the* Hot-well *a grumous precipitate of the colour of turpeth mineral*, but with the Mill-ſpring *it gave only a moſt light, ſlight precipitate:* and the reſult of my experiments on both waters in *Dublin* with that ſolution was agreeable to this, *viz.* a yellow precipitate with the *Hot-well*, but none at all with the *Mill-ſpring*; but the reſult of my compariſon of theſe waters with another ſolution was not altogether ſo agreeable to that of our Author, that is, with ſolution of ſublimate corroſive; for tho' he tells us (*b*) that the Hot-well gives a variegated pellicule with this ſolution, and that the appearances with the ſame ſolution are not ſenſibly different in the Mill-ſpring; yet upon making the compariſon with a good deal of leiſure and attention on both theſe waters tranſported to *Dublin*, I found on reiterated experiments that the pellicule formed on the ſurface of the Hot-well by the ſolution of Sublimate was variegated with much deeper and ſtronger colours than the Mill-ſpring; and thus it appears that even upon tranſportation, which muſt be a greater diſadvantage to the warm water of the Hot-well (whoſe chief virtues according to our Author reſide chiefly in the volatile parts) than to the cold water of the Mill-ſpring, the Hot-well however in all experiments gives ample evidences of a ſtronger impregnation with mineral matter, and particularly with the *Phlogiſton* than the Mill-ſpring.

(*a*) Eſſay on Waters, Part III. p. 360. (*b*) Ib. p. 359, 360.

5. The laſt evidence of the *Phlogiſton* in *Briſtol* water is, that the inſoluble part of it's reſiduum obtained by exhalation ſmells ſulphureous on the red hot iron, ſparkling and ſometimes emitting a flame.

I ſhall now cloſe this diſpute by a ſhort compariſon between the contents of the *Bath* and *Briſtol* water, which our Author has attempted, but with what clearneſs or accuracy I ſhall leave to the reader on his peruſal of the following account and the Animadverſions on it, *viz.* Briſtol *and* (a) Bath *water differ only in the latter's containing a ſmall quantity of iron, and ſome ſmall diſparity in the proportions of the oily matter and the other ingredients which each holds in common——the principal difference between the* Briſtol *and* Bath *water ariſes from the ſmall portion of the iron contained in the latter*: As to his compariſon of their Virtues, as it does not ſeem to convey much inſtruction, I ſhall paſs it by, and rather take notice of what has appeared from practical obſervation, that the operation and effects of theſe waters are oppoſite, the *Bath* water being powerfully attenuant, deobſtruent, laxative, and good in caſes where the ſecretions are diminiſhed; on the contrary the *Briſtol* water is chiefly ordered where the ſecretions are too much increaſed: the firſt is heating, the ſecond cooling, and ſucceſsfully preſcribed in hectics, coughs and the ſcurvy with heat, where the laſt is hurtful.

A more diſtinct account of the different ingredients of theſe two waters than what our Author has vouchſafed to give, will I hope be of ſome uſe in explaining this diverſity of their operation, which is therefore now ſubmitted to proper judges.

1. The Diſparity of the proportions of the ingredients which each holds in common, is not ſmall,

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(a) Eſſay on waters, Part III. p. 367.

but very conſiderable: for the *Briſtol* water ſcarcely gives 40 grains of reſiduum from a gallon, the *Bath* nearly from 128 to 144 grains from the ſame quantity.

2. The difference of the proportions of the ſaline to the terreſtrial matter in each water is very conſiderable, and ſuch as affects their operation: for, whereas it has been before obſerved that the terreſtrial matter always exceeds the ſaline in the *Briſtol* water, on the contrary, according to our Author's own account, the ſaline contents of the *Bath* water do always notably exceed the terreſtrial, and in one of the Baths as 20 to 12, *(a)* from whence is deduced the laxative quality of the laſt and the aſtringent one of the firſt.

3. There is yet another important difference, and ſuch as alſo muſt, as I apprehend, have ſome influence on the different operation of theſe waters, and that is the different proportions of the two ſalts of different qualities in each, *viz.* in one a greater proportion of marine ſalt, in the other a greater proportion of the priſmatic ſalt by ſome called Nitre, the firſt being well known for its heating, attenuating quality, being a compoſition of the marine acid with the mineral alcali, the other remarkable for it's cooling and rather incraſſating quality, being a compoſition of the vitriolic acid with a calcarious earth. Now we find by our Author's own account *(b)* that the marine ſalt in the *Bath* water is about double to the priſmatic, this laſt being the *Nitrum calcarium* of *Liſter*, of a cold and bitteriſh taſte; *(c)* but in the *Briſtol* water the laſt predominates over the firſt agreeable to his own experiment which I had a ſingular opportunity of confirming in a ſpecimen of it's compound ſalt,

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(a) Eſſay on Waters, Part III. p. 313. *(b)* Ib. p. 315. *(c)* Ib. p. 315, 316. *(d)* Ib. p. 364.

which kept dry in a bottle well corked many years, whereas a ſpecimen of the compound ſalt obtained from *Bath* waters moiſtened ſo far as to liquify, tho' kept in phials alſo cloſely corked: add to this, that the predominant taſte of the compound ſalt of the *Bath* water reſembles that of common ſalt, whilſt that of the compound ſalt of the *Briſtol* water is the genuine nauſeous-bitter proper to the calcarious Nitre of *Liſter*.

Now the predominance of this more cooling ſalt in the *Briſtol* water may help to explain it's cooling operation, as on the contrary, the predominance of the marine ſalt in the *Bath* waters may have a conſiderable ſhare in it's heating and attenuating quality, ſo that the cooling quality of the *Briſtol* water ſhould ſeem to be owing not meerly to it's inferior degree of heat, but alſo to the greater predominance of the *Nitrum caltarium* of *Liſter*, and on the contrary the heating quality of the *Bath* water to the greater proportion of marine ſalt it contains co-operating with it's ſuperior degree of actual warmth.

4. Laſtly, as to the terrene matter, or that which is inſoluble in water in the *Bath* and *Briſtol* water, it differs widely; for in the laſt it is chiefly a chalky matter, and the greateſt part of it ſoluble in the acids of nitre and ſalt, as is ſhewn above, whereas our Author aſſures us (*a*) that the far greatpart of the *Earth of* Bath *water remains untouched by acids*; and accordingly the *Briſtol* water ferments with all acids vegetable and mineral, which the *Bath* water does but obſcurely, or according to our Author (*b*) not at all; nor is the *Bath* water Earth reducible to a perfect Lime as that of *Briſtol*:

(*a*) Eſſay on Waters, Part III. p. 313. (*b*) Ib. p. 302, 303.

And now, to ſum up in one view the difference of the impregnation of the *Bath* and *Briſtol* waters——The *Bath* water contains both a volatile and fixed ſulphureous Acid in notable quantity manifeſted by the experiments above related, whereas the *Briſtol* is but very weakly impregnated with this acid, but on the contrary gives all the tokens of a predominant, antacid, abſorbent matter; and accordingly the uſe of the *Briſtol* water, but not of the *Bath* is compatible with a milk-diet.

In the *Bath* water the ſaline contents predominate over the terreſtrial; on the contrary in the *Briſtol* the terreſtrial predominate over the ſaline, and the cooling native bitter ſalt predominates over the marine ſalt, whereas in the *Bath* water the marine ſalt predominates over the other.

A phlogiſtic, oily or bituminous matter is common to them both, tho' the *Bath* water gives evidences of a ſtronger impregnation with this principle, which ſeems to be the ſeat of the milky ſoftneſs obſervable in the taſte of both theſe waters:

In the *Briſtol* water the terreſtrial or rather inſoluble matter is chiefly or principally a calcarious Earth; but in the *Bath* water it is a compoſition of the calcarious with a blue argillarcous or marly Earth, Ochre or the minera of Iron, and *Sulphur* from the impregnating Pyrite.

A TABLE exhibiting ſome of the principal Appearances on the Immerſion of Silver and the Admixture of the metallic Solutions with Æther, Gas of Sulphur, the Solutions of Sulphur natural and artificial: *Thames* Water, the Pipe-water of *Dublin*, putrid Waters, *Aix-la-Chapelle*, *Bath* and *Briſtol* Waters; whereby their various Degrees of Impregnation with the *Phlogiſton* may appear at one View.

	Effects on Silver.	*Solution of Silver in Aqua fortis.*	*Solution of Sugar of Lead.*	*Solution of Merc. ſub. corr. in diſtilled water.*	*Solution of Merc. in Aqua fortis.*	*Solution of green Vitriol.*
Æther.	No effect on a fortnight's immerſion, nor by a fortnight's ſuſpenſion in the vapor.	No diſcoloration, but a white cloud is ſuſpended.		A white cloud is ſuſpended.	A white cloud and a white cryſtaline appearance.	
Gas of Sulphur or the volatile acid of Sulphur prepared by diſtillation, gtt. xv to an ounce of diſtilled water in which the Acid is combined with the Phlogiſton.	No change by immerſion, nor by ſuſpending in the vapor for a week: but the Silver by the vapor in a ſand heat became brown and copper-coloured.	A dark brown ſubtile cloud and ſubſidence: in a ſecond trial a beautiful blue cloud.	A ſubtile white ſubſidence.	No pellicle; an extremely ſubtile white ſubſidence.	On ſtanding there appear at the bottom ſmall red ſpecks, as from the union of Sulphur and Mercury in Cinnabar: the ſolution of the Cryſtals in diſtilled w. gave a ſmall dark, ſlate coloured ſubſidence.	Quite tranſparent, no pellicle: the iron is kept ſuſpended by the vitriolic Acid.
Aqua Sulphurata formed by the union of the ſteams of hot water and Sulphur.	Changes it to a dark lead colour; and poliſhed Silver ſuſpended in the vapor 14 days was tarniſhed a little.	Clouds and ſeparations yellow, blue and red: a dark brown grumous precipitate.	A white cloud and white grumous ſediment, and a few black ſpots at the bottom.	A pale yellowiſh cloud: a white cloud in what was effete by keeping, and in forty-eight hours ſome bluiſh ſpots.	A fleſh coloured precipitate, and a pale blue and purpliſh circle above: yellow in what was effete by keeping. With the ſolution of the cryſtals yellow, and of the colour of Turpeth mineral above, and dark aſh-coloured grumes, and a dark brown ſedim.	
H. B's artificial tranſparent ſulphur-water, precipitated by acids.	Yellow, copper coloured, dark brown and blue.	White grumes at bottom, dark brown grumes above.	White, reddiſh and beer coloured above a dark brown ſediment.	Brown grumes, and a pale brown whitiſh ſediment.	A yellow, then a dark brown, floating grume and a white grumous ſedim.	A black ſediment ochre-coloured above, and a variegated pelicle
The ſame diluted.		A livid, white ſediment. In another ſpecimen a dull white, brown and reddiſh ſediment.	A whitiſh and clay coloured ſediment.	A variegated pellicle: white, yellowiſh dark brown cloud and grumes.		A variegated pellicle.
The Sulphur-water of Lucan near Dublin.	Duſky brown, copper-coloured and blue. By ſuſpending in the ſteam 48 hours a dark lead colour.	Dark brown and a black ſediment.	A dark brown cloud and ſediment: In two days a large whitiſh brown ſediment.	Yellow grumes, a dark brown ſediment, and variegated pellicle.	Yellow grumes.	A dark brown tincture; a deep red and blue ſcum.
Thames water from Dr. Lucas's Experiments.		A violet purple precipitate.	A ſlight white precipitate.	A mother of pearl coloured pellicle.	A muddy ochre-coloured precipitate.	
Pipe water of Dublin.	None.	A purple cloud.	A white cloud.	The appearances various, ſometimes a varie-	No conſiderable change, but with ſolution of the cryſtals a yellowiſh caſt	No variegation in the ſcum, either from the ſolution or from the

	Effects on Silver.	*Solution of Silver.*	*Solution of Sugar of Lead.*	*Solution of Merc. ſub. cor.*	*Solution of Merc. in Aqua fortis.*	*Solution of green Vitriol.*
Putrid Ditch water.	A duſky lead colour, not to the degree of blackneſs as from Sulphur-waters, nor the colour ſo quickly produced.	Of various colours, darker or paler according to the degrees of fetor, as a yellow, reddiſh grume, or a whitiſh, yellowiſh and pale brown one. Sometimes a ſucceſſion from a livid blue to a dark brown, yellowiſh and purple. The Precipitate ſhining, ſomewhat inflammable, of a ſtrong ſmell, but not like Sulphur.	A duſky white ſediment, and the liquor above yellowiſh: the higheſt tinge in the grumous ſediment was a light brown.	A white, brown yellowiſh or reddiſh cloud and grume: a pellicle of various colours, but this laſt appearance was not conſtant.	A white browniſh grume and pale ſediment, the ſupernatant liquor reddiſh.	A variegated pellicle from the Vitriol in ſubſtance, tho' not from the ſolution.
Aix-la-Chapelle water.	Of a gold colour, then red, orange, purple and black. By the vapors of the ſource it is almoſt inſtantly diſcoloured.	White clouds and curds, then yellow and brown: a white and a dark aſh-coloured ſediment.	A muddy milky colour. A precipitate of a dark aſh-colour, and partly of a greyiſh white.	A bright pellicle of all colours, and a yelloiſh aſh coloured ſubſidence.	A bluiſh milky hue, and a ſmall white precipitate: but with the ſolution of the cryſtals pale yellow clouds and ſediment.	Milky, and clouds of a pale yellow colour.
Bath water.	No effect on an immerſion of ſome hours, but on a longer ſtay, copper-coloured and black: and by the vapor poliſhed Silver was tarniſhed.	White bluiſh clouds at the ſource and in Dublin. The precipitate white and purpliſh, elſe dark grey: in the longer expoſed, of a pink colour: It ſparkled on the red hot iron.	Clouds with a yellowiſh caſt, which yellowneſs diſappears on the water's being ſome days expoſed. A white magiſtery with a mixture of greyiſh ſpots.	A beautiful variegated pellicle at the ſource and in Dublin, which becomes far leſs in the bottle ſome time opened.	A precipitate of the colour of Turpeth mineral, at the ſource & in Dublin, which is very fugitive after opening the bottle, and in Dublin appears only in a few bottles. The precipitate aſſumed a redneſs on the ignited iron, as in Cinnabar.	A pellicle of various colours both at the ſource and in Duhlin, which variegation does not appear in what has been long kept.
Briſtol water.	No effect by immerſion nor by the Vapor, but ſome effect by the laſt on poliſhed braſs..	Milky, and purpliſh clouds: the precipitate of a darker purple, tending to blue: the colours leſs deep in the water expoſed ſome days.	Milky clouds, and a pearl opacity.	A variegated pellicle.	A milky cloud and pale yellow: a precipitate of the colour of Turpeth mineral.	A deeply variegated pellicle, eſpecially with the Vitriol in powder on ſtanding 48 hours.
Malverne hills water imported to Dublin.	No effect.	A white bluiſh cloud, and a purple ſubſidence.	A white cloud, with a yellowiſh caſt.	A deeply variegated pellicle.	A ſubtile whitiſh cloud.	A colourleſs pellicle.

Thus this laſt Water, which is deemed one of the pureſt in England, gives ſeveral of the diſtinguiſhing Marks of an impregnating Phlogiſton, and more than Pipe-water and than diſtilled Water.

OBSERVATIONS.

I. MOST of the appearances with Metals and their Solutions are common to *Sulphur* and to the *Phlogiſton* in putrid waters, and equally marks of both, although in other reſpects and experiments *Sulphur* and *Phlogiſton* differ widely.

II. Altho' the fetid ſmell and tarniſhing of Silver be the acknowledged teſts both of *Sulphur* and *Phlogiſton*, yet theſe teſts often fail in waters, but the metallic ſolutions in this caſe often make the diſcovery, particularly the ſolution of Silver: alſo the ſolution of Mercury ſublimate corroſive, and that of green Vitriol (both acknowledged teſts of the *Phlogiſton)* do often manifeſt it by the variegated pellicle where it does not appear by any fetor in the water or by it's diſcolouring Silver.

III. The moſt ſenſible teſt of *Phlogiſton* in this Table is the ſolution of Silver, betraying ſome portion of it, not only in putrid ditch-water, but in the Pipe-water of *Dublin*, and in the *Thames* water at *London*, even from the putrid matter in each of theſe waters; and accordingly the colours are deeper in the impurer water of the *Thames* than in that with which *London* is ſupplied in pipes by other rivers, as appears by Dr. *Lucas*'s experiments, from whence may be remarked the peculiar uſefulneſs of ſolution of Silver as a teſt of the different purity of waters.

The next ſenſible teſt of *Phlogiſton* ſeems to be the ſolution of Mercury, whether in *Aqua fortis* or that of the Sublimate in diſtilled water, and eſpecially this laſt which often betrays it by the variegated pellicle where other tokens are wanting.

The leaſt ſenſible teſt of *Phlogiſton* is the ſolution of ſugar of Lead, which produces far leſs diſcolorations, and thoſe of a leſs dark colour, as appears by comparing it's different effects on the ſimple waters, the putrid and ſulphureous in the Table.

IV. The different degrees of the phlogiſtic impregnation may in ſome degree be eſtimated by the various appearances from the ſame metallic ſolutions: Thus, whereas diſtilled water exhibits feweſt of the appearances proper either to *Sulphur* or *Phlogiſton*, and for the moſt part none at all, the *Thames* water and the Pipe-water of *Dublin* exhibit more of thoſe appearances, indicating ſome admixture of a putrid matter in both thoſe waters: but putrid ditch-water exhibited thoſe appearances in a far greater degree, even ſo far as to give not only deeper diſcolorations in the clouds and precipitates from the metallic ſolutions, but to diſcolour Silver like the ſulphureous waters, tho' in a ſomewhat leſs degree, and the variegated pellicle with ſolution of Sublimate and with ſolution of green Vitriol was leſs frequent and leſs conſtant in putrid ditch-water than in the natural and artificial ſolutions of *Sulphur*, and particularly leſs frequent and leſs conſtant than in the waters of *Swadlingbar* and *Lucan* near *Dublin*, and than in *Bath* water, even while theſe waters were freſh and in no wiſe putrid; and conſequently theſe appearances in the waters of *Swadlingbar*, *Lucan* and *Bath* muſt be owing to ſome other cauſe than putrefaction.

V. Æther, a ſpecimen of the *Phlogiſton*, eludes the moſt ſenſible teſts of *Sulphur*, exhibiting no diſcoloration either with Silver or it's ſolution, nor even with the ſolution of the cryſtals of Quick-ſilver, until in the ſubſequent part of the proceſs the *Phlogiſton* be combined with the Acid of Vitriol, and then its effects on the metallic ſolutions become evident, *viz.*

VI. The Gas or volatile Acid of *Sulphur* or Vitriol (being a combination of the Acid with a ſmall quantity of *Phlogiſton*) diluted produces effects ſimilar to thoſe of *Sulphur* on Silver and it's ſolution, but in a leſs degree than ſolution of *Sulphur* diſſolved by an Alcali.

VII. The ſeveral appearances of the volatile Acid of *Sulphur* and thoſe of the *Aqua ſulphurata* formed by the union of the ſteams of hot-water and of *Sulphur*, with Silver and it's ſolution and with the other metallic ſolutions compared with the appearances exhibited by *Bath* water with Silver and it's ſolution and the other metallic ſolutions, being in a great meaſure ſimilar, may ſerve as an illuſtration of the natural compoſition of *Bath* water.

VIII. The ſimple ſulphureous waters, ſuch as *Swadlingbar*, *Lucan* near *Dublin*, and others like them and thoſe of *Aix-la-Chapelle*, agree to the artificial ſolutions of *Sulphur* in their effects on Silver and it's ſolution, and on the other metallic ſolutions.

IX. It is obſervable that the plain or cold ſulphureous waters, ſuch as *Swadlingbar*, *Lucan*, *&c.* do ſtrike much darker colours with every one of the metallic ſolutions than *Aix-la-Chapelle* water does, altho' *Sulphur* is not ſo colligible from thoſe as from this; neither does it from hence follow that they are more ſimply ſulphureous, but rather that their *Sulphur* is leſs blended with foreign matter, particularly that they contain leſs calcarious Earth, which being precipitated from the *Aix-la-Chapelle* waters in a white form, proves a means of diſguiſing the appearances, by leſſening the darkneſs of the colours of the precipitates.

X. Of the *Bath* water the following particulars are obſervable in the Table. 1. It exhibits every mark of *Phlogiſton* that *Aix-la-Chapelle* and other ſulphureous waters do, but in a leſſer degree. 2. *Bath* water has ſome effect on Silver, eſpecially its vapor, whilſt the *Briſtol* and other warm calcarious waters do not appear to have any effect on Silver: alſo the *Bath* water is more conſtant in exhibiting the variegated pellicle both with ſolution of Sublimate and ſolution of green Vitriol than *Briſtol* water, and even than Putrid water, and conſequently *Bath* water, even whilſt freſh and ſweet, gives undoubted evidences of a greater ſhare of *Phlogiſton* than *Briſtol* water or than putrid water. 3. That a water may be impregnated with the Acid and *Phlogiſton*, and yet not tinge Silver immerſed, appears from the experiment on *Gas ſulphuris* or the volatile acid of *Sulphur* diluted, which is alſo in ſome meaſure the caſe of *Bath* water; but the vapor of *Bath* water comes nearer to the vapor of ſolution of *Sulphur* than the vapor of *Gas ſulphuris* does in tarniſhing Silver more, and likewiſe in another reſpect *Bath* water comes nearer to, or reſembles more the ſulphureous waters than *Gas ſulphuris* diluted does, *viz.* in conſtantly exhibiting a variegated pellicle with ſolution of Sublimate and ſolution of green Vitriol, whereas *Gas ſulphuris* diluted gives no pellicle at all with the laſt named ſolutions. 4. *Bath* water occupies the middle place between ſuch waters as give the greateſt indications of *Sulphur*, ſuch as *Aix-la-Chapelle*, *Swadlingbar*, *Lucan*, *&c.* and ſuch as give the leaſt, as the acid Vitriolic waters of *Shadwell*, *Kilbrew*, *&c.* 5. An opinion hath commonly prevailed, that *Bath* water is of no uſe when conveyed to places remote from the fountain; but I apprehend this matter requires to be reconſidered, and that the rejecting it's uſe except at the fountain,

tain, may have proceeded from it's having been conſidered chiefly as a Chalybeat, whereas it is certain the ferrugineous impregnation is extremely ſlight, even at the fountain, nor is there in the bottles uſually ſent us any ochreous precipitation as in the common Chalybeates; wherefore it ſhould ſeem that the other principles are by far the more conſiderable: now it is evident that not only the marine ſalt and calcarious Nitre, but the Acid and the *Phlogiſton* are ſtill retained in the *Bath* water tranſported to remote places, even to *Dublin*; for here it curdles milk and exhibits various tinctures with the metallic ſolutions; and moreover it poſſeſſes even here that peculiar milky ſoftneſs by which it is diſtinguiſhed, and which makes it an agreeable vehicle for other medicines, and as ſuch may merit the attention of Phyſicians, eſpecially in ſuch caſes where the *Bath* water may have already been uſed at the fountain, which to attend may ſometimes be inconvenient to the patient.

XI. The *Briſtol* water and other warm calcarious waters exhibit with the metallic ſolutions every token of an impregnating *Phlogiſton*, but the *Briſtol* water in this reſpect falls ſhort of the *Bath* water, in having no effect on Silver, and in being not quite ſo conſtant or ſo expeditious in exhibiting the variegated pellicle with ſolution of Sublimate and ſolution of green Vitriol.

SECTION VI.

Of SULPHUR *and the phlogiſtic Matter latent in Waters.*

HAVING ſo far inveſtigated the *Phlogiſton* in the waters of *Bath* and *Briſtol*, I proceeded to trace it alſo in ſome others which do not betray *Sulphur* by the ſmell or taſte, of which I ſhall

here

here ſubjoin a ſhort account, and particularly of ſome of theſe which have hitherto been chiefly conſidered as pure element, to which alone the great virtues which they have been found by experience to be poſſeſſed of, have been attributed; and indeed the extremely ſmall and inconſiderable quantity of contents theſe waters yield upon evaporation, and their cauſing no precipitation of any terreſtrial matter by the mixture of Alcali's, but continuing clear with them and inſtantly lathering with Soap, ſeem ſtrongly to countenance that opinion; and yet the more minute inquiries which have been ſet on foot of late years by which we have learnt to give a more diſtinct account of the reſpective precipitations of the terreſtrial and phlogiſtic matter in waters, the preſence of this laſt being as ſtrongly indicated by the dark coloured precipitates exhibited in theſe waters by the metallic ſolutions, eſpecially that of Silver, as the calcarious earth is by the white precipitate thrown down by alcali's in moſt others; I ſay theſe inquiries have manifeſted ſeveral of theſe waters not to be altogether ſo pure as they have been commonly reputed; on the conrary, the proper precipitators of the *Sulphur*, or in our Author's language the *Phlogiſton*, have given evident tokens of it's being inviſibly ſuſpended or intimately diſſolved in theſe waters; and it is hoped that thoſe who from obſervation upon the operations of divers medicines on the human body, very well know that very minute and ſubtile agents may be the authors of great and good effects, will not raſhly condemn this inquiry as altogether idle or officious.

The firſt notable inſtance to this purpoſe are the celebrated warm Baths called *Favarienſes* or *Piperinæ* in *Rhætia*, deſcribed by *Scheuchzer* in his *Iter Alpinum ſecundum*, and mentioned by *Hoffman*, and both by him and *Paracelſus* deemed to be ſimple or elementary water, being perfectly limpid and void of all ſmell or taſte, and yet of great antiquity and fame in the cure of many ſtubborn diſeaſes, particularly in various nervous diſorders, in obſtructions of the liver and ſpleen, hypochondriac melancholy, malignant and ill cured ulcers, the ſtone and divers cutaneous diſeaſes; and all this by drinking as well as bathing: but tho' this water did not ſeem to ſuffer any precipitation or other change by acids or alcali's, yet it is more than probable that it is not ſo ſimple as has been ſuppoſed, even from the following more recent teſtimony of *Scheuchzer* concerning it, (compared to the accounts of the other waters like this to be here annexed) " *Certum eſt quod Sulphur continant ſubtile; certum et hoc, quod ſi diu ſteterit, ſponte præcipitatur terra quædam pinguiuſcula.*"

2. The famous waters of *Malverne* hills (*a*) ſeem to be akin to the above, and a yet clearer inſtance to the ſame purpoſe, being a light water, and which upon evaporation is ſaid to leave ſcarce a grain of ſolid contents from a gallon, the credit of which is revived of late years, being uſed with ſucceſs externally and internally in the cure of old ulcers, diſorders of the eyes, ſcrophula's, leproſies and other diſorders of the ſkin.

Now the following experiments and obſervations on this water jointly conſidered, indicate ſtrongly a ſulphureous impregnation, *viz.* the ſolution of Silver precipitated from it a powder of a deep purple colour, and when the water was ſlowly evaporated in a Silver veſſel, it tinged the veſſel of a pale yellow colour, as if it had been ſlightly gilded; and in another experiment, when it was almoſt evaporated to dryneſs, it emitted vapors of the ſmell of burning brimſtone: and to this add, that this water, notwithſtanding it's ſeeming purity, is in ſome ſeaſons apt to turn ſouriſh, and to be full of viſcid films, notwithſtanding all imaginable care hath been taken of the bottles, an appearance like what I have frequently obſerved in our *Iriſh* ſulphureous waters long kept, and correſponds to what is above mentioned from *Scheuchzer* concerning the Aquæ Piperinæ.

3. The celebrated water of *Willowbridge* in *Staffordſhire*, eminent in the cure of many diſeaſes by external and internal uſe, is a further notable inſtance of a water ſeemingly pure, (*a*) affording no ſalt upon evaporating ſeveral gallons of it to a dryneſs, of a cryſtaline colour, lathering ſmooth with ſoap, not curdling milk, nor changing colour with ſyrup of violets; and yet upon a more minute examination this water appears to be far from pure element, but impregnated with a phlogiſtic matter to a conſiderable degree: for, not only the ſolution of Sublimate gave it a deep ſack colour, and the ſolution of ſugar of Lead a blue yellowiſh colour fading to a white, but it evidently betrays a ſubtile Oil; for it feels ſmooth and oily, and on the ſides of the glaſs, after being uſed a while is obſervable a bright oilineſs, which is of ſo volatile a nature, that upon diſtilling in a glaſs body and head, it comes over upon the firſt heat, of a bright yellow colour, which was all in the recipient before the leaſt drop of water appeared.

I could enlarge the liſt of waters of this kind by divers inſtances of waters in *Ireland*, which are alſo well known to have effected many notable cures by external and internal uſe, void of taſte and ſmell, which yet betray evident marks of the *Phlogiſton* in a far greater degree than our ordinary ſoft or hard waters; but the limits I am confined to prevent my entering into a minute

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(*a*) Plot's nat. Hiſt. of Staffordſhire, and Floyer on cold Bathing.

detail of theſe: it ſhall therefore ſuffice to annex a ſhort account of one water more of this ſort, which has acquired a conſiderable reputation in *France*, and been the ſubject of ſeveral of their Memoirs, that is,

4. The cold water of *Plombiers* in *Lorain*, being uſed in inflammations of the eyes, in diſeaſes of the kidnies and bladder, and in diſorders from the heat of the breaſt, ſtomach and bowels: now this water alſo has little ſmell or taſte, cauſes little or no fermentation with acids or alcali's, diſſolves ſoap perfectly, and yields but about 17 grains of fixed contents from a gallon, and yet this water by the oily cream and variegated at the ſurface which it exhibits with the ſolution of Mercury ſublimate corroſive, together with the dark colour, inflammability and bituminous ſmell of the reſiduum ſhews an impregnating mineral Oil or Bitumen.

Thus it appears in numerous inſtances that a mineral Oil or Bitumen, and even *Sulphur* in ſubſtance is capable of being ſo far attenuated by the chymiſtry of nature as to be intimately mixed and compleatly diſſolved in water, but by what method, or by what ſubtile, powerful menſtruum this is effected, and how far this may have a ſhare in the operation and effects of theſe waters, in giving energy to the more inert ingredients I ſhall not preſume to ſay, but leave to be determined by Adepts.

It alſo appears by the experiments recited in this and the foregoing ſections compared, that the fetid ſmell proper to a ſolution of *Sulphur* by an alcali is far from being an eſſential mark of the preſence of either *Phlogiſton* or *Sulphur* in waters, but that both may ſubſiſt without it; and moreover it alſo appears to me that whatever merit our Author may have a right to claim in demanding more ſatisfactory evidences of *Sulphur* where without

out due ſupport from experiment it has only been ſuppoſed, he has greatly exceeded the bounds of prudence in rejecting it where by inconteſtable experiments it has been proved, and that he is far from meriting the thanks of the public for his contemptuous and indefenſible treatment of a whole tribe of waters which have been but little underſtood until of late, but which by their powerful and ſalutiferous effects have juſtly recommended themſelves to the further enquiries which have been ſet on foot concerning them, both as an improvement of a valuable branch of the *Materia Medica*, and as an acknowledgment of them as a largeſſe of a gracious providence for the relief of many unfortunate invalids: and among theſe may deſervedly be reckoned the lately diſcovered ſulphureous water at *Lucan* near *Dublin*, a ſituation which promiſes ſome peculiar advantages in the opportunities it affords for a true and juſt diſcovery of it's contents and of it's virtues, of which I am not without hopes of communicating ſome account in due time: for, though I could now produce numerous inſtances of the happy ſucceſs of this water in divers ſtubborn chronical diſeaſes, yet a longer ſeries of time and obſervation are required to aſcertain it's effects and eſtabliſh it's credit on a ſolid foundation; in the mean time I ſhall beg leave to remmend to the Gentlemen of the profeſſion in *Dublin* a particular attention to the *Lucan* water in ulcerations of the urinary paſſages, not only as being ſimilarly impregnated with the *Swadlingbar* water whoſe efficacy has been determined by longer experience, but as having actually upon trial in ſeveral of theſe caſes, with a proper regimen and due perſeverence, given an encouraging proſpect of their proving equally ſucceſsful.

POSTSCRIPT *to the Accounts of the* Bath *and* Briſtol *Waters.*

THE Compiler of the above Experiments and Obſervations being aware of an objection that may be made againſt the Credit thereof by reaſon of his living remote from both theſe places, thinks it neceſſary to intimate, that as the communication between *Bath*, *Briſtol*, and *Dublin* is very eaſy, and the intercourſe between them very frequent, he has taken care to relate not only the Experiments of his Adverſary and others which were made on the ſpot, but to get theſe repeated and improved by others of a recent date alſo made on the ſpot in both the places above mentioned:

And among theſe it were an injury to the public to ſuppreſs the following, which were made with the utmoſt care and attention, and communicated ſince the printing off the above Sheets, by a faithful Correſpondent, *Joſeph Fry* Apothecary in *Briſtol*; and the rather, as they afford a corroborating evidence, concurring with the others above given, of the preſence of the *Phlogiſton* in *Briſtol* water, as well as in the baths of *Aix-la-Chapelle* and thoſe of *Bath* in *Somerſetſhire*, tho' in a leſs degree.

His Words are theſe:

" I placed a piece of poliſhed Braſs and a Sil-
" ver ſpoon over a glaſs veſſel during a ſlow
" evaporation of the *Hot-well* water. The Braſs
" was variegated with a few ſpots of a pearl-co-
" lour, but the metal was not apparently corro-
" ded. The Silver ſpoon was unaltered."

" I alſo placed the ſame Metals over the glaſs
" uſed in a like evaporation of the *Mill-ſpring*
" water. The Braſs over this laſt acquired about
" twice as many ſpots as the other, but the metal

“ was not apparently corroded. The Silver ſpoon
“ was a little brown, like Plate which has lain
“ by ſome time.”

Briſtol, 13 9 mo. 1762.

From hence it appears that both theſe waters do exhibit more or leſs of the ſame evidences of the preſence of the *Phlogiſton* as the waters of *Aix-la-Chapelle* and *Bath*, altho’ in a leſs degree. I muſt grant that by theſe experiments compared, it ſhould ſeem that the *Mill-ſpring* contained more of the *Phlogiſton* than the *Hot-well*, but as the fallacy of concluſions from a ſingle experiment has been abundantly ſhewn above, ſo neither are they to be relied on in the preſent caſe, ſince other experiments do not concur with the above, but rather evince the reverſe, *viz.* more *Phlogiſton* in the *Hot-well* water than in that of the *Mill-ſpring*.

SECTION VII.

Of Nitre in Waters, with a more explicit account of the Nitre of the Ancients.

AFTER all theſe altercations with regard to *Sulphur*, I do not know but it may be poſſible that our Author and I may happen yet to ſhake hands on the ſubject of Nitre, being actually agreed in theſe three important points: 1ſt. that there is no ſatisfactory evidence of Saltpetre in mineral waters. 2dly, that the Nitre of the ancients is found in the waters of *Aken* and others. 3dly, that the *Nitrum calcarium* of *Liſter* is the ſalt impregnating the bitter purging waters:

And though the modern chymiſts are generally agreed in appropriating the term Nitre to that Salt which yields the acid peculiar to Saltpetre upon diſtillation, yet as our predeceſſors have called two other Salts by that name, altho' ſo far from yielding the acid peculiar to Saltpetre, that one of them ſometimes yields a volatile alcali, beſides giving other evident marks of an alcali, and the other a vitriolic acid, it will behove us hovever, if we would profit by the experiments and obſervations made on them whether by ancient or more modern writers, ſtill to retain the mention of thoſe names by which they were formerly known; and in order to this the following diſtinctions are now humbly offered, being ſuch as it is hoped will miniſter no occaſion for contention, *viz.*

1. *Nitrum orientale impurum terreſtre: Natron: Nitrum Veterum* Walerii *Mineralogie, Nitrum Veterum celeberrimum.*

2. *Nitrum recentiorum fulminans Salpetra dictum.*

3. *Nitrum calcarium* Liſteri. *Sal catharticum amarum nativum baſi terreſtri, veteribus non prorſus ignotum, a recentioribus accuratius deſcriptum.*

Now as Saltpetre does not appear to have any ſhare in the impregnation of waters, it will be of no uſe to make further mention of it here; but as the diſtinguiſhing characters of the other two ſalts which have hitherto paſſed under the denomination of Nitre, have not as yet been but imperfectly given, I ſhall take this opportunity of exhibiting a ſomewhat more explicit and diſtinct account of each.

And firſt, as to the Nitre of the ancients, our Author himſelf, tho' he generally reſtricts the ſenſe of the term Nitre to Saltpetre, yet expreſsly acknowledges the preſence of the other in waters, and particularly, (*a*) that *the Salt of Aken baths is to be looked upon as identically the ſame thing as the Nitre of the ancients, whence theſe waters may be juſtly called nitrous:*

And indeed, altho' the ancients uſed the word Nitre in a very lax and vague ſenſe, ſometimes hardly diſtinguiſhing it from common ſalt, for the moſt part deſcribing it to be bitter, yet ſometimes ſcarce ſenſibly bitter, ſometimes ſalt and bitter; (and indeed it is rarely found pure and unmixed) yet it is plain from the writings of *Galen* and *Pliny*, that what they moſt frequently underſtood by this name was an alcaline ſalt (and accordingly *Pliny* mentions a factitious ſort, *ex quercu cremata*) ſharper than common ſalt, and in operation a powerful diſcutient, attenuant and detergent, and probably ſomewhat purging; and indeed the old writers both ſacred and prophane have left us ſuch diſtinguiſhing marks of what they moſt frequently called Nitre, that it is not eaſily miſtaken; and an enquiry how far the ſalts obtained from any mineral waters are poſſeſſed of thoſe marks will be of the more importance, becauſe it will enable us to determine how far we may be ſafe in

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(*a*) Eſſay on Waters, Part III. p. 130.

in applying the virtues attributed to their Nitre to the correſponding ſalt impregnating any waters.

The ſalt of *Aken* baths is a notable inſtance to this purpoſe; and here I gladly embrace the opportunity of paying ſome tribute to the real merit of our Author, by adopting and inſerting, as of uſe and importance, ſeveral of his experiments on the ſalt obtained from *Aken* baths, to which I ſhall beg leave to add ſome obſervations and experiments of my own tending to give a more clear and diſtinct account of the ancient Nitre, and of the ſalt correſpondent to it which is found in divers mineral waters.

1. The *Salt of Aken baths cauſes* (a) *an ebullition with all Acids, and with the concentrated or ſtrong acids of nitre or vitriol yields copious white fumes like ſea ſalt, or rather Soda.*

The conflict of the Nitre of the ancients with Vinegar is implied in the account given of it in the ſacred records (*b*): the latter appearances with the acid of Vitriol are obſervable in the ſalts of many other waters beſides thoſe of *Aken.*

2. *It changes* (*c*) *Syrup of Violets inſtantly to a bright green.* This alſo is the caſe of the Salts afforded by many other waters. The ancients indeed were not acquainted with this experiment, but they have left us another teſt of their Nitre tending to the ſame purpoſe, being an equal indication of an alcaline ſalt, *viz.* that it renders Cale and other pot-herbs more green (*d*), it being a well known fact that alcaline ſalts advance the colour of the tinctures of green herbs.

Now our Author has taken care to inform us, that (*e*) *the people of Aken boil their coleworts, lettuces,*

(*a*) Eſſay on waters, Part III. p. 108. (*b*) Proverbs xxv. 20 (*c*) Eſſay on Waters, loc. cit. (*d*) Plin. lib. 31. c. x. (*e*) Part III. p. 62.

aſparagus, common and kidney beans, peaſe, &c. in the bath waters, finding by experience that the boiling of theſe vegetables is facilitated and expedited, and that they acquire a peculiar grateful flavour and tenderneſs, and have their colour preſerved or improved by means of the ſalts in theſe waters.

This is not peculiar to the waters of *Aken* and their ſalts, but has been obſerved in ſeveral other mineral waters ſimilarly impregnated, and their ſalts, which alſo in reiterated experiments have been obſerved to render Cale boiled in them more green and more tender; and this laſt effect the Nitre of the ancients alſo had, as appears from the following obſervation of *Theophraſtus*, (*a*) *Quidam Nitrum injiciunt ut igni Braſſica mandata facilius coquatur et tenera dulciſque ſentiatur.* The waters impregnated with ſuch a ſalt ſeem to be the moſt oppoſite in their effects to thoſe called crude or hard.

There is another experiment analogous to this, which I ſhall ſubjoin as a further illuſtration of the properties of the ancient Nitre, and of its identity with the ſalt found in divers mineral waters, *viz.* that their Nitre alſo rendered raw fleſh more tender, as appears from the following obſervations in *Plutarch* (*b*): *Quæ cauſa ſit quod mactatæ carnes, v. g. galli, ſi de ficu ſuſpendantur, teneraſcunt? Reſpondetur ſpiritum calidum acrem incidendique vi preceditum ficus emitterre, iſque incidit et concoquit carnem avis. Idem fit ſi frumenti acervo imponatur, aut juxta Nitrum, calore id efficiente:*

And I have obſerved ſeveral waters impregnated with the mineral Alcali, particularly thoſe of *Selters* and *Bourne*, and their Salts in ſome late experiments, as well as the ſame kind of ſalt im-

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(*a*) De cauſis Plantarum, lib. 6. c. 14.

(*b*) Quæſt. 10. l. 6. Sympoſiac.

pregnating ſeveral of our *Iriſh* ſulphureous waters, to have had the ſame effect on raw beef and mutton, *viz.* to make it more tender, and not only ſo, but at the ſame time to redden it as the modern Nitre or Saltpetre; but the double effect, *viz.* of rendering it both more tender and more red is alſo common to the artificial alcali.

3. *The ſalt of Aken waters runs into cryſtals reſembling thoſe of Soda or Kelp, and bears great analogy to this uſeful ingredient in ſoap, glaſs, &c.* (*a*).

Thus it appears that the ſalt obtained from the baths of *Aken* is a compoſition of the native or mineral alcali and muriatic ſalt, as in the *Soda*, but with a greater predominance of the (*b*) alcali; and here it agrees to the Nitre of the ancient *Egyptians*, which was ſo remarkable for imbibing the moiſture of the air, that it was uſually carried in pitched veſſels to prevent it's melting (*c*): and the like compoſition is alſo obſervable in the ſalts obtained from many waters in other parts of the world, particularly in the following waters in *England*, *France* and *Ireland*, (and undoubtedly in many others) *viz.* thoſe of the baths of *Bourbon*, and *Mont d'or*, and in the following ſulphureous *Engliſh* and *Iriſh* waters, *viz. Quin-camel*, *Chadlington*, *Sutton-bog*, *Bilton*, *Wiggleſworth*, *Swadlingbar*, *Mechan*, *Aſhwood*, *Derryleſter*, *Derryhence*, *Killeſher*, and *Lucan* near *Dublin*, all or moſt of which give marks of a predominant alcali combined with a little marine ſalt; ſo that we are now enabled, upon a longer ſeries of obſervation and experience to affirm that the mineral Alcali or Nitre of the ancients is a frequent ingredient in mineral waters, eſpecially thoſe of the ſulphureous kind: and that this ſhould be ordinarily combined with Sea-ſalt

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(*a*) Eſſay on Waters, Part III. p. 108, 109. (*b*) Ibid. 109.
(*c*) Plin. Nat. Hiſt. lib. xxxi. cap. x.

agrees very well to the late diſcoveries which have been made, that the mineral Alcali, *Natrum* or Nitre of the ancients is no other than the baſis of marine ſalt, unſaturated by it's proper acid, with which when it is ſaturated, it becomes a genuine marine ſalt.

Our Author's obſervation of the œconomical uſe of *Aken waters in waſhing and ſcouring wool, woollen and linen clothes in them* (*a*) ſhews their ſaponaceous quality like that of the Nitre of the ancients (*b*), an effect not peculiar to the waters of *Aken*, but common to divers other mineral waters impregnated with the like ſalt, and is one notable criterion by which they are diſtinguiſhed from the waters impregnated with the calcarious Nitre, which have a contrary effect, conſtituting a hard water not diſſolving ſoap, whereas the mineral Alcali when pure, mixes equably with ſoap; and our Author's account of the correſpondency of the ſalt of *Aken* baths to the Soda in it's *ſweetening*, (*c*) *reſolvent*, *deterſive*, *aperitive*, *deobſtruent and diuretic* qualities is agreeable to the nature of the impregnating ſalt and to *Galen*'s account of Nitre, *viz.* *Nitrum, ſi intra* (*d*) *corpus ſumatur, ſecat et extenuat lentos craſſoſq; ſuccos longe potentius quam Sal.*

And next, as to the analogy which the *Salt* of *Aken* baths bears to the Nitre of the ancients in making glaſs, this alſo has been found to be not peculiar to it, but upon poſitive tryals to be alſo the caſe of the ſalts of divers other waters alike impregnated, as in thoſe of *Bourbon*, *Clifton*, *Wiggleſworth* and *Sutton-bog*.

Thus it appears that the ſalt obtained from *Aken* baths as well as from divers other waters correſponds in the moſt diſtinguiſhing characters to the

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(*a*) Eſſay on Waters, Part III. p. 62. (*b*) Jerem. 2. 22.
(*c*) Eſſay on Waters, Part III. p. 109. (*d*) Lib. 9. de ſimp. med. fac.

mineral Alcali or Nitre of the ancients, and conſequently by the expreſs conceſſion of our Author ſuch waters may be denominated Nitrous, or in modern terms Alcaline. It is true our Author endeavours to eſtabliſh an Acid in the *Aken* and moſt other waters, not without ſupport from experiment; however, that the predominating ſalt in the *Aken* waters in their natural ſtate previous to any decompoſition of it's parts either ſpontaneous or by the fire, is truly of the alcaline kind, appears from our Author's own deſcription of the taſte of the water, *viz.* that it is *ſaline*, *ſomewhat bitter*, *and lixivial or urinous*, as is alſo the ſalt obtained from it, and to this agree the ſcouring quality of the water itſelf as above mentioned; and therefore the Analyſis of this water is juſt, and ſuch as exhibits it's ſalts in their natural ſtate.

2dly, I proceed next to give alſo a more minute account of the *Nitrum calcarium* of *Liſter*, being a ſalt wholly diſtinct from the foregoing, not giving the waters it impregnates a ſoft, ſaponaceous quality like that, but the contrary in thoſe commonly called hard waters, and is the native ſalt impregnating the bitter purging waters, even according to our Author (*a*), whoſe conſtituent parts we are become better acquainted with by the diſcoveries lately made of the conſtituent parts of that moſt uſeful imitation of it called *Epſom Salt*, being altogether ſimilar to thoſe of the native bitter purging ſalt, both conſiſting of a terreſtrial matter reſembling the *Magneſia* combined with the vitriolic acid, and both agreeing in the nauſeous bitter taſte and in the purging quality.

Now the waters impregnated with this ſalt have been alſo generally called Nitrous by the far greater part of the moderns who have treated of mineral waters, particularly *Georgius Agricola*, *Baccius* and

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(*a*) Eſſay on Waters, Part I. p. 93, and 123.

and by Dr. *Short*, who has obliged the world with elegant and accurate figures of varieties of ſalts of this denomination in his firſt volume on mineral waters: and *Liſter* pronounces it to be *omnium ſalium frequentiſſimum:* and there are apparent veſtiges of it in waters in all parts of the world; and it is more than probable with me that many, or rather the greater part of the waters called Nitrous by the ancients were impregnated with, not the ſaponaceous or alcaline ſalt above deſcribed, but chiefly with this ſalt; for thoſe ſaponaceous waters wherein the *Natron* predominated, were but rarely, and here and there ſcattered, with them as well as with us, *v. g.* beſide the *Aken* waters, the two following are recorded as rarities, *viz.* the *Lacus Aſcanius* mentioned by *Ariſtotle* cited in the Notes on *Pliny* as being ſo Nitrous that they cleanſed and took ſpots out of clothes by being dipt in them, and another in *Armenia* mentioned by *Agricola* having the ſame effect; theſe I ſay are rarities and mentioned as ſuch; on the contrary, the bitter purging waters appear to me to have been frequent with them as they are with us, not only becauſe of the bitter taſte which they conſtantly aſcribed to their Nitre, and *Pliny* where he teaches us how to ſweeten bitter waters ſeems to uſe the words bitter and Nitrous promiſcuouſly, *viz.* (*a*) *Nitroſæ aut amaræ aqua polenta addita mitigantur ut intra duas horas bibi poſſint*, but alſo becauſe of the purging quality common to their Nitrous waters and to the *Nitrum calcarium* and the waters therewith impregnated; and moreover, becauſe ſuch waters ſeem plainly to be mentioned both by *Galen* and *Vitruvius* as frequent and well known, in theſe two following paſſages: *Nonnulli uſu* (*b*) *aquarum ſponte naſcentium quibus ſulphuris,*

(*a*) Nat. Hiſt. lib. 24. c. 1. (*b*) De ſanit. tuenda. lib. 4. c. 4.

aut bituminis aut Nitri vis ineſt, vere vel autumno quotannis ſoliti excrementa vacuare.

Eſt aquæ frigidæ (*a*) *genus Nitroſum, uti Pinnæ, Veſtinæ, Cutiliis aliiſq; locis ſimilibus quod potionibus depurgat, alvumq; tranſeundo ſtrumarum mimuit tumores.*

Thus has antiquity given a ſanction to the word Nitrous as applied to the bitter purging waters, being impregnated with a ſalt altogether diſtinct from that of the ſalt or brine ſprings, and whoſe compoſition we are of late become much better acquainted with by the labours of the moderns in their various experiments on the artificial *Sal catharticum amarum* beautifully illuſtrating the compoſition of the native bitter purging ſalt in waters, the conſtituent parts being found to be the ſame in both.

Now our Author, who has not without cauſe cenſured others for confounding *Sulphur* and Bitumen, has here the misfortune of having ſubjected himſelf to a like cenſure with regard to *Glauber*'s ſalt and the ſalt of the bitter purging waters, which he confounds in ſeveral places of his work, (*b*) particularly in his preface to the ſection on the ſaline waters, being the general title he affixes to the bitter purging ſprings of which he treats, where, giving an account of the general compoſition of the minerals impregnating theſe waters, he ſays, that they (*c*) *conſiſt chiefly of the vitriolic acid ſaturated with different earthy matters, chiefly the baſis of Sea-ſalt :*

But more expreſly and clearly in p. 316. Part III. where treating of the priſmatic ſalt in *Bath* waters, he ſays, *it indeed anſwers the character of* Liſter's *Nitrum calcarium, being to all intents and*

(*a*) Vitruvius apud Authores de Balneis (*b*) Eſſay on Waters, Part I. p. 93, and 123. (*b*) Ibid. Part II. p. 94.

purpoſes the ſame, a natural bitter purging ſalt, in all reſpects agreeing with the natural vitriolate priſmatic ſalt, or with the artificial bitter purging ſalt known by the name of it's inventor Glauber, *whoſe compoſition is an union of the vitriolic acid with the mineral alcali or baſis of Sea-ſalt.*

Now it was but highly reaſonable to have expected from ſo accurate a Chemiſt as our Author, that his obſervations and experiments ſhould relate to the real *Glauber*'s ſalt, which he has here deſcribed in words that cannot be miſtaken; yet, certain it is, that this ſalt does not in all reſpects agree to the calcarious Nitre of *Liſter*, nor to the natural vitriolate priſmatic ſalt in purging waters, but differs from both in divers important phænomena exhibited by each, upon the moſt accurate compariſon: for 1. The baſis of the real *Glauber*'s ſalt is a mineral alcali, but the baſis of the bitter purging ſalt, as is juſtly obſerved by that more accurate Chemiſt *W. Lewis*, is a terreſtrial matter anſwering to the *Magneſia*, as is evident from hence, that the ſolution of the true *Glauber*'s ſalt always continues clear on the addition of an alcali, whereas the ſolution of the calcarious Nitre and the ſolution of the bitter purging ſalt natural and artificial on ſuch addition always exhibits a large white terreſtrial precipitate, even as in the proceſs for preparing the *Magneſia* from the *Sal catharticum amarum.* 2. The native bitter purging ſalt in waters, the *Nitrum calcarium*, and the artificial *Epſom* ſalt, are found to curdle milk, whereas the true *Glauber*'s ſalt being uſed in the ſame proportion, did not produce any *coagulum*, which may ſuggeſt the reaſon why ſome few of the purging waters either do not curdle milk at all, or in a far leſs degree than others, even from a diverſity in their impregnating ſalts, which, in ſuch few as do not curdle milk, approach nearer to the true

Sal Glauberi, the *Sal Polychreſt*, vitriolated Tartar and *Sal diureticus*, all which have likewiſe an alcaline baſis and are found to have no effect in curdling milk. 3. A third variation in the appearances exhibited by the *Sal catharticum amarum* or now falſly called *Glauber*'s Salt, (and ſold for ſuch in our ſhops, being the artificial *Epſom* ſalt in larger cryſtals,) from thoſe exhibited by the true *Glauber*'s Salt, is, that this laſt, upon an exact compariſon, was found to have a far leſs effect than the firſt, in improving the colour of Greens, producing a leſs deep and leſs lively green in Coleworts and Peaſe boiled with an equal quantity of each, than the *Sal catharticum amarum* falſly called *Glauber*'s ſalt in the ſhop, and that impregnating our hard waters, nay, even leſs than the common ſoft pipe water of *Dublin*.

Upon the whole, it appears that here is, not only a confuſion of words, but of things, whilſt two different ſalts, *viz.* the real *Glauber*'s ſalt and the native bitter ſalt in purging waters are repreſented to be the ſame.

The mineral Alcali then is not the Baſis of the *Sal catharticum amarum* artificial or natural, but is the proper baſis of marine ſalt, a ſalt altogether diſtinct from the other both in the figure of it's cryſtals and in it's qualities and effects, and the waters alſo wherein either of theſe are reſpectively predominant muſt alſo differ accordingly, tho' our Author has not thought fit to give any account of the Salt ſprings in his ſection of ſaline waters, but only of thoſe wherein the *Sal catharticum amarum* predominates, particularly thoſe of *Epſom* and *Cheltenham*, tho' the others are alſo frequent in moſt parts of the world, and merited a diſtinct conſideration. It is true thoſe ſalts are variouſly mixed and combined in different waters; however, as it is of uſe to know the ſimples that enter into a compoſition, ſo it is to be acquainted with the diſtinct nature of theſe ſalts ſo variouſly combined in waters; and where either of them predominates, as the *Sal catharticum amarum* evidently does in ſome, and the marine ſalt in others, we have no other way of judging of their effects a *priori* than by conſidering thoſe of the reſpective predominating ſalt, which effects, as they are very different, and do not ſeem to be ſo much attended to as they ought, I ſhall ſubjoin a few hints tending to ſhew wherein their principal difference conſiſts: In the *Sal catharticum amarum* the Acid is leſs ſaturated, or more diſengaged, and in all experiments diſpoſes the blood to ſome degree of inſpiſſation: it is cooling, quenches thirſt, is adapted to a hot bilious ſtate of the juices; it is a more powerful and at the ſame time a more gentle purge than marine ſalt: on the contrary in the marine ſalt the Acid is more ſaturated, and the mineral Alcali rather prevails, hence it attenuates and thins the blood, heats the body, excites thriſt, is uſeful where a greater ſtimulus, irritation and heat are wanted, and in a cold lentor of the juices; and it is a rougher purge, as are alſo the Brine ſprings, and found by obſervation to be injurious in hectics and conſumptive caſes, in which caſes the other waters in ſmall quantities have been obſerved to be uſed with good ſucceſs (*a*).

Conſiſtently with the above account the waters impregnated with the different ſalts mentioned have been reſpectively diſtinguiſhed into the Saline and Nitrous in a late treatiſe on Mineral waters, and indeed according to our Author, properly enough, if by Nitre be meant *Liſter*'s *Nitrum calcarium*; but he alledges without the leaſt reſerve, that this *has not one property of* (*b*) *the Nitre of the*

(*a*) Method. ſynops. of min. Waters, p. 72. (*b*) Eſſay on Waters, Part III. p. 316, *ancients or moderns*; in which declaration how much prudence, attention to, or real acquaintance with the Nitre of the ancients or moderns is ſhewn I ſhall leave to the conſideration of the reader: indeed it has not the alcaline quality of the *Natron*, nor the fulminating one of Saltpetre, but at the ſame time that it is undoubtedly poſſeſſed of ſeveral diſtinguiſhing qualities of both the ancient and modern Nitre is very obvious: for 1. Did not the antients conſtantly attribute Bitterneſs to their Nitre? Hear *Galen*, "*Sapor amarus ex Nitroſi provenit intentione* (*a*)" and "*Amara et Nitroſa craſſam materiam attenuant, ſicut ſunt Iris, Amygdala amara, Nitrum, Orobus, Lupinus* (*b*) *&c.* Now the *Nitrum calcarium* and the waters therewith impregnated are poſſeſſed of this quality in the moſt eminent degree. 2. Does the *Natrum* found in *Aſia* correſponding to the Nitre of the ancients give a ſenſation of coldneſs on the (*c*) tongue as Saltpetre does? The priſmatic ſalt of *Bath* water which anſwers to the *Nitrum calcarium (d)*, and the *Nitrum calcarium* itſelf is remarkable for the cold and bitter taſte. 3. Was the ancient Nitre remarkable for increaſing the greenneſs of Calc boiled with it? So is the native bitter purging ſalt in waters. 4. Is the modern Nitre called Saltpetre remarkable for reddening the fleſh of beef or mutton boiled with it? The effect of the *Sal catharticum amarum* natural and artificial is the ſame; and marine ſalt has the like effect, even from its participation of the Bittern or *Sal catharticum amarum*, from which mixture Sea-ſalt is ſeldom entirely free, (*e*) and our hard waters have the like effect on greens and fleſh from the ſame principle. 4. Had the Nitre of the ancients a

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(*a*) De med. ſimpl. fac. lib. 1. cap. 36, (*b*) De Oculis.
(*c*) Hill's Hiſt. of foſſils. (*d*) Eſſay on waters, Part III. p. 315.
(*e*) See Lewis's notes on Neuman.

purging quality? The waters they called Nitrous were eminent for it, and from the paſſage in *Galen* (*a*) here referred to compared with the known effects of the waters of *Aix-la-Chapelle* and *Vichy* impregnated with a ſalt like the Nitre of the ancients, it appears that they knew no Nitre but what was purgative; for which quality our *Nitrum calcarium* and *Sal catharticum amarum* natural and artificial are eminent; for the priſmatic ſalt or calcarious Nitre impregnating waters in but a very ſmall quantity renders them powerfully cathartic.

So much may ſuffice, if not to eſtabliſh the application of Nitrous to the waters impregnated with the *Sal catharticum amarum*, at leaſt to apologize for the uſe of it in that ſenſe until a better and more diſtinguiſhing appellation for it be propoſed; for indeed that which has been propoſed by (*b*) our Author, who would have it called the *univerſal Vitriolic*, or *native Vitriolate* ſalt, ſeems liable to ſome exceptions: had he called it *Sal vitriolatum baſi terreſtri*, or *Sal ſeleniticus*, as ſome have done, I might not have quarrelled with him; but how far the multiplying a variety of names not more clearly expreſſive of the nature of the thing ſignified tends to the improvement of ſcience, and whether or no, whereas we have divers mineral waters ſtrictly and properly called Vitriolic, yielding a true Vitriol, the affixing the appellation of Vitriolic without further explanation or diſtinction as above ſpecifying its peculiar baſis, do tend to confound it with real Vitriol found in other waters, I ſhall refer to the determination of the critics in language and chymiſtry; only ſhall beg leave to intimate, that in the opinion of another Author and as good a judge of both, ſuch ſalts ought not to be denominated Vitriolic: for he, ſpeaking of

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(*a*) De Sanit. tuenda, lib. 6. c. 10. (*b*) Eſſay on Waters, Part. II. p. 100.

the *Fel Vitri*, makes the following remark: *The* Fel Vitri *ariſing to the ſurface of the glaſs made with Flint*, altho' no vitriolic ſalt, *is found to participate largely of that Acid, and to be nearly ſimilar to that of* Sal mirabile.

And now, to ſum up the reſult of the foregoing Obſervations: 1. It appears that there are many waters beſides thoſe of *Aken* wherein the mineral alcali or Nitre of the ancients is the predominating ſalt. 2. There is a greater number, and which ſeem to be diffuſed thro' all parts of the world, being the bitter purging waters, wherein a ſalt compounded of the vitriolic acid and a terreſtrial matter, or in other terms the calcarious Nitre of *Liſter* predominates, tho' rarely without marine ſalt. 3. There are others found alſo in moſt parts of the world, in which the predominating ſalt is the marine, being a ſalt compounded of the marine acid and the mineral alcali, tho' not without ſome mixture of the foregoing ſalt called Nitre by *Liſter* and many others. 4. There is another claſs of waters altogether diſtinct from the foregoing, wherein the vitriolic acid predominates and is combined with a metallic baſe, yielding a true Vitriol ferrugineous or cupreous, but chiefly the firſt, and theſe undoubtedly will maintain their right to the title of Vitriolic.

Dublin, 7th, 7th Mo. 1762.

TRACT II.

THE ANALYSIS OF MILK, AND THE DIFFERENT SPECIES THEREOF.

By JOHN RUTTY, M D.

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PREFACE.

WHOEVER preſumes to publiſh any thing as of importance to the world, ought to be acquainted with what his predeceſſors have already done, or elſe expect to be liable to be treated as one that has contributed to increaſe the now juſtly complained of plague and burden of ſcience in the multitude of unneceſſary productions. Having therefore had recourſe to the writings of the ancients on the ſubject of Milk, I do acknowledge that they, being well acquainted with the dietetic part of medicine, were not ſtrangers to the different qualities of the Milks of different animals, as which of them had moſt ſerum and leaſt curd, et contra, and accordingly, which of them was moſt or leaſt eaſy of digeſtion and diſtribution, which of them was laxative, and which conſtipated the belly moſt: and they gave the Aſs's Milk boiled in large quantities, as to twelve pints and more, as a purge void of acrimony, altho' to what principle this was owing they left to be inveſtigated by the induſtry of the moderns.

The following ſummary account of the virtues and vices of Milk from *Galen* and *Dioſcorides* ſhews what diſtinct and juſt conceptions they had of it and its Whey.

" *Corpus alit, alvum emollit: thoracis ac pulmonis partibus Lac omne utile: omnibus auxiliatur internis* *exulcerationibus, præſertim faucium, pulmonis, interaneorum, veſicæ et renum, efficax contra roſiones exuſtioneſq; ab exitialibus medicamentis factas, uti a cantharidibus* &c." to which *Ætius* adds, "*in urinæ difficultate et acri egeſtione Alvi——et ad acres et mordices fluxiones utiliſſimum.*"

"*Capiti, niſi quis ipſum habeat admodum firmum non accommodum, ut et nec hypochondriis quæ levi de cauſa inflantur; necnon eos renes offendit qui calculis generandis ſunt appoſiti, jecur autem offendit his qui hoc affectu facile prehendi poſſunt.*"

"*Lac omne reſpuendum ſpleneticis, hepaticis, comitialibus, vertiginoſis, nervorum vitio laborantibus, febricitantibus et capite dolentibus, niſi quis purgationis gratia ſchiſtum præbeat*:" the Whey being preferred to Milk in ſome of the caſes enumerated, and particularly for the purpoſe of purging. The moderns alſo agree in exploding Milk in cachexies and obſtructions of the *viſcera*, as increaſing ſuch diſorders by the *craſſamentum*, but give Whey the preference, and frequently order Milk diluted with mineral waters, as on the contrary in very emaciated bodies, Milk is preferred to Whey. Herein however the moderns ſeem in ſome ſort to differ from the ancients, *viz.* in recommending it, not only in the Gout, but in the Stone according to *Dolæus.*

Theſe obſervations reſpect Milk in general; but it is neceſſary to remark, that the general and indiſcriminate ordering of a Milk diet without regard, not only to the paſture of the animal and ſeaſon of the year, but more eſpecially the difference of the animal from which it has been taken, muſt be attended with very uncertain effects; and indeed the Ancients were well aware of the importance of attending to this difference; giving the preference to Women's milk as moſt congruous to our nature, and next to the Aſſe's, as one of the thinneſt (and near akin to the Mare's milk, and both laxative) and moſt eaſy of digeſtion and diſtribution.

It muſt however be acknowledged that their accounts of different Milks are not free from confuſion and uncertainty; for *Pliny* (*a*) pronounces the Aſſe's milk to be *craſſiſſimum*, contrary to *Galen*, and *Galen* himſelf repeatedly aſſerts as a well known fact, that Goat's milk is leſs thick and leſs fat than Cow's milk, and *Ætius* confirms the ſame error, and *Pliny* in the placc cited ſays, *Bubulum caſeo fertilius quam Caprinum:* Whereas, that the reverſe is true with reſpect to the Milks of theſe animals, at leaſt in this country, (as well as in *Scotland* and *France*, as far as appears from the obſervations yet made there) will abundantly appear in the ſequel; a difference undoubtedly worthy the attention of Phyſicians, as one of theſe Milks has been known to be uſed with ſucceſs where the other hath failed, for reaſons obvious enough in the ſequel; and when *Mangetus* in his collections attributes to Cow's milk a ſuperior excellency in correcting the acrimony of poiſons, I apprehend this praiſe ought rather to be attributed to the milk of the Goat and Sheep:

Nor indeed is what *Hippocrates* himſelf hath ſaid concerning Goat's milk altogether unexceptionable, *viz.* that it opens the belly more than Cow's milk; for if *Galen* be right in aſſerting that Milk conſtipates the belly more in proportion as it contains more curd and leſs ſerum, then *Hippocrates* muſt be wrong in affirming that Goat's milk moves the belly more than Cow's milk (*b*), or at leaſt this will not hold true of the Goat's milk of this country, as having much more curd, and not more, but rather leſs of the ſaline principle, as will appear in the ſequel, agreeably to what *Dioſ-*

corides

(*a*) Lib. XI. cap. 41. (*b*) Lib. 2. de Diæta.

corides ſays, viz. " *Alvum minus tentat caprinum*," who has alſo done juſtice to Sheep's milk in pronouncing it *craſſum et præpingue*, and therefore the diſtinguiſhing character which *Mangetus* from *Avicen* has left us of it, highly merits attention, *viz.* " *Ovillum craſſius cæteris et minus ſeroſum, et hinc quoq; in renum debilitate, mictu ſanguinis, diabete ovillum præhabetur, cui in confortando renes non eſt medicina compar.*"

Now in order to remove in a great meaſure the confuſion and uncertainty of the different accounts of the ſeveral Milks above mentioned left us by venerable antiquity, and as an eſſay towards eſtabliſhing with a greater degree of preciſion the diſtinguiſhing characters of each Milk, I here offer a faithful examination of the ſeveral Milks in uſe in theſe parts of the world, by the following eaſy proceſſes, being ſuch as offer little or no violence to the conſtituent parts, and conſequently free from the objection juſtly made to the common proceſſes in chymiſtry, as by the torture of the fire entirely changing the bodies examined from their natural ſtate.

I am not ignorant that *Hoffman*, *Ludovicus Teſti* mentioned by *Valentini*, and Profeſſor *Gaubius* at *Leyden*, have made conſiderable advances towards giving the *Analyſis* of Milk, and even of the different ſpecies thereof, and particularly in extracting what they have called *Saccharum lactis*, but how properly ſhall be hereafter conſidered; and as the following is a more minute examination of this and the other parts that enter into the compoſition of the heterogeneous fluid called Milk, from a ſeries of Experiments made in concert on the ſeveral ſpecies thereof in the neighbourhood of *Dublin*, it is here humbly offered as a further elucidation and more explicit account of this matter.

Neuman's account of Milk lately publiſhed is far from being explicit with regard to its Salt, which he examines only as changed by the fire, whereas that Salt in the following account is obtained only by a mild heat and ſuch as produces very little change in it from its native ſtate.

The following account of Milk and its different ſpecies was drawn up long before the publication of Dr. *Young*'s inaugural Diſſertation concerning Milk, as appears by the dates of each. That gentleman has publiſhed divers uſeful truths on this ſubject, and made a great progreſs towards aſcertaining the reſpective component parts of the ſeveral ſorts of Milk in uſe, and from him, ſince the firſt fair tranſcript of my Papers I have adopted ſome hints and acknowledged them; but as he has left ſome things untouched, particularly with regard to the different qualities of the Salts obtained from the different ſorts of Milk, I found no cauſe to ſuſpend the preſent publication, not only as exhibiting ſomethings new and worthy of attention in practice, but by reaſon of ſome variety in our Experiments, tho' in the general they are found nearly to correſpond and prove a reciprocal confirmation of the truth of each other, and for another reaſon alſo, that, as this gentleman has given this agreeable ſpecimen of his abilities to proſecute and improve this ſubject, he may be incited ſo to do according to his declared laudable intention.

THE

ANALYSIS of MILK,

Particularly that of the

WOMAN, ASS, MARE, COW, GOAT, AND SHEEP.

THE ſenſible qualities of theſe ſeveral ſorts of Milk are thus diſtinguiſhed:

Woman's Milk is of a ſaccharine ſweetneſs, far ſweeter than Cow's Milk.

Aſſe's Milk is alſo much ſweeter than Cow's Milk, but not ſo ſweet as Woman's Milk.

Mare's Milk approaches near to Aſſe's; and Woman's Milk in the ſaccharine ſweetneſs is much ſweeter than Cow's or Goat's Milk, and on comparing them looks much thinner.

Goat's Milk was inferior in ſweetneſs to either of the three foregoing, but ſenſibly ſweeter than the beſt Cow's Milk I could procure in and about *Dublin*, and alſo more white, as is likewiſe its cream and curd than thoſe of the Cow, which have a caſt of yellow; and it yields a whiter Whey, not readily becoming clear, as the Whey from Cow's milk.

Sheep's milk is of a rich, oily taſte, and to the touch of the tongue feels of a thick conſiſtence, and evidently thicker than any of the above Milks, and is inferior in ſweetneſs to Cow's milk.

The ſpecific Gravity of thoſe ſeveral Milks was thus determined: As the ball of the Hydrometre riſes above the ſurface of Milk, it is requiſite that this be diluted:

Wherefore Cow's milk and Aſſe's milk being equally diluted, *viz.* with three parts of water to two of milk, the Hydrometre ſtood in the firſt at 1. 0, in the ſecond at 0 $\frac{2}{5}$ and conſequently the Aſſe's milk was conſiderably heavier: And Mare's milk and the beſt ſtrippings of Cow's milk being equally diluted, the Hydrometre ſtood in the firſt (as in the Aſſe's in the former experiment) at 0 $\frac{2}{5}$, but in the ſecond at 1. 0. Goat's milk and Sheep's milk being equally diluted and compared to Cow's milk, appeared to be conſiderably more heavy than Cow's milk. The Goat's milk particularly and Cow's milk equally diluted compared, the Hydrometre ſtood in the firſt at 0 $\frac{1}{5}$, in the laſt at 0 $\frac{4}{5}$.

Scholium.

Aſſe's milk and Mare's milk, tho' they have far leſs cream and leſs curd than Cow's milk, yet are as much heavier than Cow's milk as Goat's milk is, and why? I anſwer, from the predominance and larger proportion of the ſaline principle in the Aſſe's and Mare's milk, which gravitates more than the Cream or Craſſamentum in their diſſolved ſtate. I proceed next to the Analyſis of Milk, and 1ſt, The Analyſis without fire.

Of the Cream.

Woman's milk	gave of Cream	ſcarce one third	of what Cow's milk did.
Aſſe's milk		not above half	
Mare's milk		not half	
Goat's milk		three times as much as Cow's milk.	
Sheep's milk		by gueſs above three times more than Cow's milk. *viz.* about two ounces from half a pint.	

N. B. Theſe proportions of Cream are not given as invariable; for the Milks themſelves differ at different times from divers circumſtances, as that which is firſt from that which is laſt drawn and called Strippings, from the ſeaſon of the year, paſture, and different ſtate of the animal, *v. g.* ſoon after it has brought forth it's young it's remarkably thinner and ſtronger in the ſaline principle.

Scholium.

Cow's milk, according to *Mangetus*, is preferable to other milks for correcting the acrimony of poiſons on account of it's ſuperior Oilyneſs: Now this holds true only in compariſon to Woman's, Aſſe's and Mare's milk; for the Goat and Sheep's milk evidently challenge the preference in this reſpect to Cow's milk.

Of the Curd.

Woman's milk	coagulated by the ſame quantity of rennet as Cow's milk, gave of curd	very little, even not $\frac{1}{6}$ of what Cow's milk did.
Aſſe's milk		a little more than half in one experiment, and not ſo much as half in a 2d experiment as (a) Cow's milk did.
Mare's milk		nearly $\frac{1}{3}$ of what Cow's milk gave, nor was it eaſily coagulated.
Goat's milk		nearly 3 parts to 2 of what the pureſt Cow's milk did, in another trial above double, and the whey was whiter; and both the whey and curd of a ranker ſmell, and the curd tenacious.
Sheep's milk		double to what Cow's milk gave, and in another experiment more than double, and Dr. Young obſerves the curd to be more firm than that of the Cow.

(a) *Neuman* makes the curd of Aſſe's milk to be much leſs, *viz.* but $\frac{1}{5}$ of that of the Cow's milk, and moreover, ſays that it is leſs denſe and heavy than that of other milks.

Scholium.

What *Galen* repeatedly aſſerts of Cow's milk compared to Goat's milk, that it is *pinguiſſimum et craſſiſſimum*, is quite erroneous, at leaſt with regard to thoſe animals in this country and in *Scotland*, according to Dr. *Young*'s experiment on the contents of both theſe milks, and particularly on the caſeous parts of both theſe milks, as likewiſe in *France* according to *Helvetius*, a difference undoubtedly worthy of attention in ſome circumſtances of tabid patients, Goat's milk having been found to ſucceed in ſome of thoſe caſes when Cow's milk has failed, as Dr. *Baynard* obſerves, and the reaſon for the difference may be eaſily deduced from a compariſon of their reſpective Analyſis.

2dly. The Analyſis by fire, tho' by a mild degree of heat not much altering the quality of the products.

Woman's milk	gave of Extract from a Pint	Oz. i ſs. Oz. i.ſs. ſcrup. ii. gr. ii. Oz. i. dr. v. gr. xxxvi. viz. in three different trials.
Aſſe's milk		Oz. i ſs. Oz.ii. dr.vii. gr.vi. Oz.i. dr. vi. gr. vi. Oz. i. dr. vi. gr. xxiv. viz. in four different trials.
Mare's milk		Oz.ii. dr. vii. gr. xxviii. Oz. i. dr. vii. ſcru. i. Dr. vi. ſcr. ii. gr. vi. viz. in three different trials.
Cow's milk in the Country		Oz. i. dr. iii. ſcrup. i.
Cow's milk in *Dublin*		Oz. i. dr. i.
——— in June		Oz. i. dr. iii. ſcru. i.
——— in January		Oz. i. dr. iv. Oz. i. dr. iv. ſcrp. ii. viz. in two different trials.
Goat's milk		Oz. i. dr. v. gr. xxiv. Oz. i. gr. xxxvi. in two different trials.
Sheep's milk		Oz.ii. dr. vi. gr.xviii and nearly the ſame in a ſecond experiment, and in a third above oz. iii. dr. iv.

Corollary.

Corollary.

The Sheep's milk exhibited on evaporation by far the greateſt quantity of contents of all the ſix, the Mare's the next; then the Aſſe's and Woman's, and laſtly the Goat's and Cow's milk, which laſt gave the leaſt quantity of all. The greater proportion of contents in Goat's than in Cow's milk is confirmed by Dr. *Young*'s experiments in *Scotland.*

The Compariſon of the Extracts of the ſeveral Milks.

The Extract of Woman's milk was	White yellowiſh, (*a*) of a high ſaccharine ſweetneſs, and not without ſome ſaltneſs, unctuous, viſcid, inflammable on the red hot iron, with a white flame, and in another trial partly bluiſh and partly purple, without notable fetor, and left but a ſmall quantity of grey ſalt aſhes.
The Extract of Aſſe's milk was	Yellowiſh, very ſweet, oleaginous, with a high flavour not altogether diſagreeable: it moiſtened a little in the air. And to this agrees *Neuman*'s obſervation, that Aſſe's milk has this remarkable particularity, that it yields a more fetid ſmell in the fire than any other (*b*).

(*a*) The yellowiſh colour of theſe Extracts ſeems to be owing to ſome ſmall degree of empyreum, which if it were carefully avoided by leſſening the heat when the evaporation was nearly finiſhed, the colour would be nearly white.

(*b*) It is an important remark of Dr. *Young*, that the ruminating animals, *viz.* the Cow, Sheep and Goat is more aceſcent, and participates more of a vegetable nature than that of the [non-ruminants, *viz.* Woman's, Aſſe's and Mares] for which reaſon the former Milks if the ſtomach can bear them, are to be preferred where there is a tendency to putrefaction.

The Extract of Mare's milk was	Pale-yellowiſh, ſweet, with a flavour like that of Aſſe's milk, and it felt granulated under the tongue, like honey or ſugar, (an evidence of its ſaline quality) 40 grains in a red hot crucible burnt with a white, then blueand purple flame, emitting a ſmell like an old cruſt of bread burnt, and it left four grains of aſhes greyiſh and of a taſte ſomewhat ſaline.
The Extract of Cow's milk was	White-yellowiſh, unctuous, of a ſaltiſh taſte, ſweetiſh and ſubacid, far leſs ſweet than the Extracts of Woman's, Mare's and Aſſe's milk, but reſembling the taſte of a farinaceous matter mixed with a little ſugar. It moiſtened a little in the air. It made no ebullition with Oil of Vitriol. Rubbed with Solution of Mercury ſublimate corroſive it whitened a little. Half a dram in the red hot crucible, emitted a white, green and blue flame, and left four grains of black, ſalt aſhes.
The Extract of Goat's milk was	Yellow, of a ſweetiſh taſte as of ſomething farinaceous a little ſweetened, far ſhort of the ſweetneſs of the Extracts of Woman's and Aſſe's milk, as alſo far leſs unctuous. It burnt with a white, then purple and blue flame. A dram burnt left four grains of aſhes grey and of a ſaltiſh taſte.
The Extract of Sheep's milk was	Of a pale yellow when obtained by a ſlow fire, and of a taſte farinaceous and moderately ſweetiſh, and ſubacid.

OBSERVATIONS.

1. THESE Extracts of the ſeveral Milks, being obtained by a ſmall degree of heat, give the reſpective native taſtes of the ſeveral milks, being their Oil, Salt and Curd more cloſely approximated by the avolation of the aqueous parts; and from hence appear the congruous qualities of thoſe three Milks, the Woman's, Aſſe's and Mare's, being diſtinguiſhed by their peculiar ſaccharine ſweetneſs, whereas the Extracts of the Milks of the Cow, Goat and Sheep, ſhew either a Salt ſpecifically different from that in the three former, or at leaſt the ſame or a like ſalt blended with a large proportion of a milder ſubſtance.

2. I kept theſe Extracts of the ſeveral Milks in gallypots covered only with paper in a cloſet where there had been no fire, for ſeveral months, and ſome of them above a year, and they continued ſweet, without any acquired rancidity, and of a grateful taſte, ſo far that my Cat, (a delicate, pampered animal) would feed greedily on them, and once devoured the fruit of my labours, the Extract of Aſſe's milk; and if in the preparation, all empyreum has been carefully avoided by uſing a gentle heat, and timely taking the veſſel off the fire, theſe Extracts will by trituration with water, or by diſſolving in water over the fire (as a dram of the Extract of Cow's and Aſſe's milk will readily do in an ounce or two of water, or an ounce in a pint) yield a liquor partly yellowiſh and partly white, farinaceous, and of a ſweet, not ungrateful taſte, like the reſpective milks from which they were drawn, *viz.* in the firſt of a rich, pleaſant taſte, in the ſecond more ſweet: I will not indeed ſay altogether of ſo grateful a flavour as the original milks, nor ſo ſmoothly mixed, but tolerably pleaſant, and which might be uſed as a

ſuccedaneum for Milk at Sea, analogous to the portable Soups made from inſpiſſated Broths, and perhaps as good a ſubſtitute for Milk as the others are for Broth; for indeed neither do the gelatinous parts of Animals nor Milk loſe much by decoction, except the aqueous parts.

Wherefore, as this Age has diſtinguiſhed itſelf by excogitating and recommending divers methods and medicines highly conducive to the preſervation of our Mariners from that deſtructive diſeaſe the Scurvy, it may not perhaps be unſeaſonable to propoſe ſuch a preparation, *viz.* of the Extract from Milk or of the Salt from Whey as deſerving a place in the ſea-cheſt, in order that being kept in a dry warm place, a *ſuccedaneum* might be ſupplied for Milk and ſweet Whey, which perhaps might prove of great uſe at Sea to ſuch delicate, morbid, opulent Valetudinarians as could bear the expence of it.

I ſhall next procceed to the conſideration of Whey, being the lixivium of Milk, or the Solution of its proper Salt.

Cow's Milk Whey diluted with an equal quantity of water buoys up the Hydrometre as high as Milk diluted with an equal quantity of water does, and why? becauſe the Whey being a ſolution of the meer Salt in the ſame volume of a watery fluid gravitates more than the Oil and Curd in their attenuated ſtate.

Now as we have ſeen that the different Milks above mentioned differ conſiderably in their productions whether by fire or otherwiſe, it will appear by the ſequel that there is no leſs a diverſity in their ſeveral Wheys, and therefore I apprehend the following minute examination of theſe to be no ſuperfluous labour.

Doctor *Dyvernois*, who lately publiſhed a Diſſeration on the Sugar of Milk, was at a great deal of pains to procure this Salt by Cryſtallization; but I doubt the ſmall quantity obtained in that method will hardly compenſate for the tedioußneſs of the proceſs; and I find that Whey depurated by repeated decoctions and deſpumations yields by meer evaporation over a ſlow fire a genuine, pure and white Salt, which agrees to the other in the ſeveral appearances thus deſcribed by that Author, *viz.*

"*It is dry, white, of a ſweet, agreeable ſmell and ſweet taſte, like Sugar or Manna, a little ſaltiſh, melts eaſily on the tongue, ferments neither with acids nor alcali's, burns with ſmall ſparks on lighted charcoal; and that its doſe is from half a dram to two drams twice a day, that it keeps the body open,* &c."

1. The firſt experiment I made for obtaining the Salt from Woman's milk, *viz.* by diſſolving the Extracts in diſtilled water, filtering and with great difficulty ſeparating the oily matter and exhaling to dryneſs a ſecond time, was not ſo ſucceſsful as the ſecond method to be ſubjoined by repeated boiling and ſcumming the Whey, and then evaporating by a ſlow fire; for I found that the repeated evaporations leſſened the ſweetneſs of the ſalt, which ſalt thus obtained was brown, ſweetiſh, ſomewhat viſcid, and imbibed the moiſture of the air. It did not, as Sal Ammoniac and Salt of Urine, excite any ſmell when rubbed with Salt of Tartar. On the red hot iron it was inflammable, and for the moſt part conſumed, but did not emit a fœtid ſmell like burnt horn or other animal ſubſtances. In the red hot crucible half a dram emitted a white and purpliſh flame, and left two grains of grey, ſaltiſh aſhes, which gave a ſtrong acid fume with Oil of Vitriol:

But the Salt obtained from the Whey of Woman's milk coagulated by rennet and exhaled to dryneſs, was white, with only a ſlight caſt of yellow: it was granulated like honey, of a ſweetiſh ſtrong ſmell, of a ſalt and ſweet taſte, tho' far leſs ſweet than the Extract:

It moiſtened a little in the air:

On the red hot iron it melted and flamed, and left a ſmall quantity of ſalt aſhes, and thus burnt it ſmellt like a cruſt of bread burnt.

It was double in quantity to what the ſame proportion of Whey from Cow's milk yielded.

I took two drams, two ſcruples and ſeven grains of it diſſolved in a pint and half of water, (to which it gave the colour and taſte of Whey) but was not at all purged by it, nor was any ſenſible effect produced by it except a little wind.

2. The Salt of Aſſe's milk, being four ſcruples, from five ounces of the Whey depurated by repeated boiling and ſcumming, was white, a little brown at the edges, granulated under the tongue, of a ſweet and a little ſaltiſh taſte, of a ſomewhat high flavour, viſcid.

It moiſtened in the air:

Rubbed with Oil of Vitriol it emitted a fume of an acid ſmell.

Half a dram burnt in a crucible left five grains of duſky grey ſalt aſhes.

The Whey of Aſſe's milk gave above treble the quantity of Salt that the ſame proportion of the Whey of Cow's milk did, and according to *Dyvernois* ſix times as much: however, it is much more loaded with Salt, and this of a much ſweeter quality than the Salt from Cow's Whey.

I took three drams of this Salt diſſolved in a pint of water and had but one ſtool more than uſual, and that not looſe.

3. From the Whey of Mare's milk depurated as above I obtained two drams, two ſcruples from half a pint of Milk, of white Salt, granulated like honey, of a mild, ſweet ſmell, of a ſweet and

ſaltiſh taſte, much ſweeter than the Salt of the Whey of Cow's or Goat's milk.

It gave near treble the quantity of Salt that the Whey of Cow's milk did, though in another experiment only one third more; but in a third experiment more than treble.

Rubbed with Oil of Vitriol it emitted an acid ſmell.

Half a dram burnt in a crucible left four grains of black, ſalt aſhes.

I took two drams, ten grains of this Salt diſſolved in half a pint of Whey without any purgative effect, but only ſome ſlight gripes and a little wind, ſo that in ſuch a ſmall doſe it appears to be only eccoprotic, tho' in a larger it muſt undoubtedly prove purgative.

4. From the Whey of Cow's milk depurated as above and ſlowly exhaled, I got, even from milk procured from the country, only half the proportion of Salt to what Woman's milk yielded, which was granulated, and of the conſiſtence of honey, very different in taſte from the Salts of Woman's, Aſſe's and Mare's milk, being ſaltiſh and ſweetiſh, and in another ſpecimen ſubacid; and indeed it ſeemed to be more remarkable for ſaltneſs than ſweetneſs. It emitted a white and purple flame in the red hot crucible, and half a dram left five grains of ſalt aſhes.

I took an ounce of this Salt diſſolved in a pint of water, and was not purged by it.

5. The Salt of Goat's Whey compared to that from Cow's Whey was as 108 of the firſt to 152 of the laſt from the ſame quantity of each, (from whence we may conclude that whatever peculiar effects Goat's whey may have is by no means owing to any greater proportion of Salt it contains) which Salt, like that of the Cow's Whey, falls greatly ſhort of the ſweetneſs of that of the

Woman's, Aſſe's and Mares Whey, and is alſo as remarkable for ſaltneſs as ſweetneſs: It was of a white, browniſh colour, granulated like honey, of a ſmell ſomewhat ſtrong, of a ſaltiſh, ſubacid and ſweetiſh taſte, ſo that Goat's whey ſeems to be not leſs, but rather more aceſcent than Cow's Whey.

The ſame Salt from Goat's whey flamed on the red hot iron, and ſmelt like burnt coffee.

6. The whey of Sheep's milk yielded but a ſmall quantity of Salt, and far leſs, even than Goat's whey, which Salt was of a pale yellowiſh colour, of a farinaceous ſweetiſh, ſaltiſh, and ſubacid taſte, and felt granulated under the tongue.

Corollaries.

1. The Woman's, Aſſe's and Mares milk have more Salt, but leſs Oil and Craſſamentum; but the Cow's, Goat's and Sheep's milk have more Oil and Craſſamentum, and far leſs Salt; and of the three laſt the Sheep's has moſt Oil and Craſſamentum, next the Goat's, the Cow's leaſt of theſe three. The Curd of the Goat's milk is moreover obſerved to be of a more coherent nature than that of the Cow's, from whence as well as the greater proportion of curd, Goat's milk is apt to coagulate in weak ſttomachs and create anxiety, even in ſome caſes to a great and dangerous degree, to prevent which Sugar and Salt are ordered to be mixed with it, an inconvenience to which the thinner milks, are not ſo liable, particularly the Aſſe's milk, as *Ætius* long ago obſerved, who alſo obſerves the *Vililigo alba* to be the conſequence of a long continued uſe of Sheep's milk. Hence not only Aſſe's milk, but alſo the Woman's and Mare's are to be preferred whereever a milk of more eaſy digeſtion and diſtribution, and leſs apt to create obſtructions is required, and where there is a tendency to fever, a

weakneſs of ſtomach, or a diſpoſition to coagulate or corrupt milk, as alſo where ſome degree of attenuation or opening the belly is wanted.

On the other hand, the three other milks are more balſamic, and to be preferred where ſomething more demulcent, agglutinating, incraſſating and conſtipating is required, in which qualities the Goat's and Sheep's milk do notably exceed the Cow's, which in theſe reſpects obtains an intermediate place between the two laſt mentioned and the three thinner milks of the Woman, Aſs, and Mare.

From the above Analyſis alſo, *viz.* from the predominancy of the *craſſamentum* and the ſmaller poroportion of the ſaline principle in Goat's milk compared to Aſſe's, moſt clearly appears the reaſon of the following obſervations of *Helvetius*, (a) *viz.*. "In *hectic fevers attended with a looſeneſs, as alſo in all long and obſtinate fluxes Goat's milk is to be preferred to Aſſe's, and is particularly proper to reſtore children in conſumptions, as well as other extremely thin and emaciated bodies.*" *viz.* as being more nouriſhing and leſs ſtimulating, though how far the circumſtance of it's being harder of digeſtion may determine it's uſefulneſs in particular caſes muſt be left to obſervation.

Cor. 2. The Salt of Woman's, Aſſe's and Mare's milk is diſtinguiſhed from that of the Cow, Goat, and Sheep, both by it's quantity and quality, as being not only in a far greater proportion in any given quantity of milk, but in quality much more ſweet, approaching to the ſweetneſs of Sugar or Manna, whereas the Salts of Cow's, Goat's and Sheep's milk are envelopped with ſome ſofter matter, which leſſens the ſtimulating and purgative operation, whence in the above tryals

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a) Traite des Maladies les plus frequentes & des remedes.

tryals, which were made with both, leſs than half an ounce of the Salts of the whey of the three firſt animals acted as ſtrongly or more ſtrongly as an eccoprotic than a whole ounce of the Salt of Cow's whey.

Cor. 3. The Salt of milk is a mild, oily Salt, and may be juſtly called a *Sal medium*, not only as being neither acid nor alcali, but as occupyiug a middle ſtate between the vegetable and animal Salts, not yielding by the fire that fetor which all animal ſubſtances do, but rather a ſmell like that of a farinaceous ſubſtance, as of a cruſt of Bread or Coffee burnt, and not ſo far elaborated by the concoctive powers as Salt of Urine, from which it differs ſpecifically in not diſmiſſing a volatile alcali on being rubbed with Salt of tartar, like that and Sal ammoniac; nor moreover has it that degree of purgative quality which Salt of Urine has, being much milder in ſenſible qualities and operation.

Cor. 4. The Salt of all the Milks reſembles the Sugar of the Reed in the oleaginous, inflammable quantitity, being by far the greateſt part conſumed in the fire; but there is this notable difference, that the Salt from Milk always leaves a ſmall proportion of ſalt aſhes, whereas that from the Reed leaves a far leſs quantity of aſhes, and thoſe not ſalt, but inſipid.

Cor. 5. The appellation of Sugar of Milk is by no means applicable to the Salt obtained from Cow's, Goat's and Sheep's milk. There is indeed a peculiar ſaccharine ſweetneſs in the Woman's, Aſſe's and Mare's milk, as alſo in the ſeveral Extracts obtained from them; but when we come to ſeparate the ſaline from the oily parts as far as we are able, in order to make the Salt, this loſes of the ſweetneſs and manifeſts a ſaltiſh taſte, and therefore I apprehend ſhould be called rather *Sal* *lactis* than *Saccharum lactis*, eſpecially when we ſpeak of Milk in general.

Cor. 6. The *Sal lactis* is not a ſimple Salt, but combined with a pittance of marine ſalt, of the preſence whereof I looked upon the following appearances collectively conſidered to amount to a demonſtrative proof, *viz.* the ſaltiſh taſte of the Salts of every one of the above Milks, their attracting the moiſture of the air, their emitting an acid fume with Oil of Vitriol, as did alſo their aſhes, and their ſolution turned grumous with ſolution of Silver: appearances all proper to marine ſalt, ſo that, as Authors have diſcovered marine ſalt in the bones, blood and urine of animals, we conclude it is alſo an ingredient in Milk: but this matter is put out of all doubt by an experiment of *Geoffroy* in the Memoirs of the royal Academy 1762, who from the *lixivium* of the *caput mortuum* of whey left upon diſtillation, obtained cubical cryſtals like thoſe of *Sal gem*, as did Dr. *Tho. Young* of *Edinburgh* alſo in a late experiment on Whey inſpiſſated.

Having ſo far deſcribed the contents of the ſeveral ſorts of Milks and their Wheys, I ſhall next conſider the practical uſes of the laſt, unto which the Antients were alſo far from being ſtrangers, as being milk deprived of its groſſer parts, and as ſuch far better adapted to the purpoſes of cleanſing and purging; and accordingly they ordered Whey in divers chronical diſeaſes, as we do mineral Waters, even where Milk was improper and forbidden, as appears from *Dioſcorides*'s account, viz. " *Serum lactis datur quibus ſine acrimonia volumus dejectionem moliri, ut melancholicis,* [*comitialibus*, to whom the ſame Author expreſly forbids Milk] *lepris, elephanticis et erumpentibus toto corpore papulis*:" to which add particularly Goat's

Whey in *Spleneticis (a)*, (to whom *Dioſcorides* expreſly forbids Milk) and that of Aſſe's milk, in *morbis articularibus* (*a*), and my ingenious Correſpondent hereafter named remarks, that even Aſſe's and Mare's milk can ſeldom be born by the Aſthmatic unleſs diluted with Spa or other water.

The account given us by *Dioſcorides* of the method in which Whey was taken, being very ſimilar to our modern uſe of mineral waters, is worth attending to, viz. " *Bibitur heminis per intervalla ſingulis uſque ad quinas* (perhaps five of our pints or more, and *Hippocrates* gave 16 *heminæ* (*b*) of Aſſe's milk as a purge) *ita ut intercedentibus ſpatiis potantes obambulent.*" *Mangetus* mentions (*c*) it's being drank medicinally in ſpring for fifteen days or a month from half a pint to a pint or a pint and half with ſugar, or with ſugar of roſes; but at our mountains of *Mourne* the much larger doſe in which it is given comes nearer the practice of the Ancients. *Dioſcorides* orders it to be made with vinegar and honey, but the before named Author prefers that made with Rennet or of the flower of the prickly wild Artichoke to the Whey prepared with Acids, eſpecially in perſons ſubject to coughs or other diſorders of the breaſt threatening a conſumption. There is alſo another method of curdling milk perhaps worth mentioning here, as the whey ſo obtained is deemed the ſofteſt and mildeſt of all others, *viz.* by beating up the milk with eggs, adding a little ſugar and ſetting it over the fire.

N. B. The following account of Goat's Whey having been drawn up by careful obſervation and attendance to facts in caſes which fell under the

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(a) (a) Beverovic. Idea Medicinæ Vett.
(b) Le Clere Hiſt. de la Medicine.
(c) Bibliothec. pharm med.

Author's own notice at the mountains of *Mourne* for a ſeries of years, are here offered as an improvement upon the practice of the Ancients, both with reſpect to a more minute detail of the method of uſing it, and particular inſtructions for directing and regulating its operation, and a more clear and diſtinct diſcovery of its virtues in the cure of diſeaſes where it has either not been uſed, or the time, ſtages of the diſeaſe or other circumſtances wherein it ought to be uſed, have not been clearly pointed out: and I am deſired to intimate, in behalf of the Author, that if the Public ſhall deem the Hints here given worthy of notice, he may poſſibly in proceſs of time improve them by conſiderable additions, ſuch as experience may furniſh.

Dublin, A. D. 1758.

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TRACT III.

PRACTICAL
OBSERVATIONS
On the USES of
GOAT's WHEY.

By JAMES KENNEDY, M. D.

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SECTION I.

Of the PASTURE *and* FOOD *of* GOATS.

IT is with good reaſon remarked by Goat-herds that thoſe animals do not preſerve their health and vigour when confined to low ſoils and ſituations. A rocky mountainous ſoil that will bear no vegetable except Furze, Brambles and ſuch like, is the only one that agrees with them, ſo that it may be almoſt taken for granted that their milk and whey will not anſwer medicinal purpoſes ſo well on any other, not only from their natural food, but alſo from their not having ſuch ſpirits and alacrity; and moreover it is ſaid they do not live half ſo long on low paſture grounds as on mountains. Such ſoils as are generally choſen for them, are obſerved to produce ſeveral ſorts of plants not very common elſewhere on which Goats are alledged to feed plentifully. This however I did not take for granted, but with great induſtry, for many years, attended them at their browſing grounds, to make remarks; and I obſerved a general rule with them, not to touch an herbaceous vegetable, if there was any ſort of tree, ſhrub or of the fruteſcent kind to be had. Hence it is, that where a herd of them has fed ſome time, every plant of this ſort is ſtript of leaves, as far as they can reach: It would require a large extent of ſhrubby ground, to ſupply them with leaves for a whole ſeaſon: they quickly difdiſpatch every ſort but furze, which on account of its prickles and the quantity to be had, becomes inexhauſtible to them, and indeed makes the greater part of their food, in ſome places, ſuch as *Tullymore* in this country, where large herds are conſtantly hept.

Honeyſuckles they ſearch after above all things; next for bramble leaves and what others they can come at. St. John's wort they devour greedily: *Allium Sylveſtre*, pretty common there, they will feed on, but not eagerly.

I have often thought that the ſuperior medicinal efficacy of Goat's whey, could not be accounted for ſolely from the difference in their food from that of other animals, but that there was much to be allowed for the conſtitution and nature of the Goat. I have many times compared their whey with that of Cows, where their food muſt have been preciſely the ſame, and always found it remarkably ſtronger and ranker.

SECTION II.

Of GOAT'S WHEY *in general.*

MESUE of *Damaſcus*, who lived about the latter end of the ſixth century, ſeems to have had a pretty accurate notion of the peculiar efficacy of Goat's whey as a medicine, in ſaying that it attenuates, opens obſtructions, deterges and purges gently; and he gives a brief catalogue of its virtues, but which is not complete without adding its nutritive and diuretic qualities.

The only method of making it at the mountains of *Mourne* is with rennet.

There cannot be too much care to have the whey as clear as poſſible, the neglect of an attention to which circumſtance, has to my knowledge, been of bad conſequence in ſeveral caſes. Let it be made as clear as you will, a conſiderable quantity of curd remains blended with it; which appears on boiling it when the curd called the crop-curd riſes to the top; and whitiſh ill-made whey will lye heavy on moſt ſtomachs, produce inflations, and not paſs freely either by urine or ſtool, but by proper care it may be made as limpid as any other whey.

Whey poſſeſſes both the alterative and evacuating qualities: as an alterative it may be ſaid to diluent, attenuant, reſolvent, demulcent and nutrient. It's evacuating virtues conſiſt in it's promoting the ſenſible evacuations of ſtool, urine and ſweat.

It has an undoubted right to be accounted a diluent of the firſt rank, having the advantage of water in being ſofter, ſomewhat ſaponaceous and having already circulated thro' the minute veſſels of an animal body, ſo that it will probably penetrate more than water, and more effectually diſſolve noxious ſalts and prepare them for evacuation by their proper emunctories:

It's attenuant and reſolvent properties may bear ſome debate. It muſt be owned that in theſe it yields to mineral waters, but when we conſider its eſſential ſalt or *ſaccharum*, blended with a fine animal oil, and that it abounds with the juices of plants that are eminent for theſe qualities, we may readily acknowledge that it has a right to be called attenuant and reſolvent even from reaſoning *a priori*: Indeed where it is uſed in diſorders that require active penetrating medicines, the aſſiſtance of ſuch will be very expedient, perhaps neceſſary, chiefly of the neutral ſalts.

Whey becomes a noble antidote againſt morbid acrimony in the blood, by it's demulcent quality:

as a diluent and demulcent it conſpires to correct all ſorts of acrimony. By theſe it calms the rapid motion of the blood in hectics, allays the parching thriſt ſo grievous to ſuch ſubjects, and at the ſame time relaxes the general ſpaſm and too briſk vibration of our fibres, common in theſe diſorders, of which we can't fail to have a lively idea on touching the hard, tenſe, ſticky pulſe of ſuch. But Whey ſhines forth in no quality more than in its nutritive. What a high opinion *Virgil* had of this appears by his

——— *Acremque Moloſſum*
Paſce ſero pingui ———— Geo. 3.

In phthiſical caſes, when the blood is thin, florid and highly acrid, the hectic fever high, a rapid maraſmus uſually attends, not to be checked perhaps by any other medicine, ſeldom indeed by this. *Briſtol* Water may dilute, may cool, may evacuate the ſeptic acrimony by the kidneys, but all this time the blood continues as abſolutely unfit for repairing the great waſte made by the putrid fever, as before. In this caſe it muſt yield the precedence to Whey, which has perhaps all it's good qualities, it's gentle aſtringency excepted, and beſides, affords the only food which the ſhattered organs of digeſtion and ſanguification are capable of converting into nouriſhment. It ſeems indeed to be the only thing deſerving the name of cordial and reſtorative in ſuch caſes; inferior to nothing except human Milk ſucked out of the breaſt. Theſe are things I myſelf have a lively ſenſe of from perſonal experience, having been in this ſituation, and retrieved only by a proper courſe of the non-naturals, but chiefly of Goat's Whey, which I found anſwer every intention of food and medicine. No Epicure ever received more pleaſure from his Ortolans or his Turtle, than I have many times received from a draught of Goat's

Whey upon waking in a morning, after a high hectic paroxyſm and profuſe ſweat thro' the whole night, being quite parched with thirſt. I am not yet arrived at ſuch a perfect ſtate of health, but that I find great comfort and advantage from it, eſpecially at the Whey ſeaſon.

SECTION III.

Of the evacuant properties of Whey.

BY diluting, attenuating, reſolving obſtructions and ſheathing acrimonious ſaline humours, impurities of the blood are corrected and prepared for evacuation, which is promoted in a moſt eaſy and agreeable manner by Whey. The principal outlet which nature uſes to throw off the ſaline pecant humours, is the urinary paſſage. There is perhaps no mineral water which promotes the urinary diſcharge more effectually than well prepared Goat's Whey properly drank: for by improper management it will be prevented from operating duly this way. Lying long in bed in the morning and ſleeping after drinking it, drinking it too haſtily, and in too great quantity, not uſing propar exerciſe along with it, and in fine, neglecting to uſe proper medicines to aſſiſt, are generally the reaſons of it's failing in this effect. Indeed if it purges ſpeedily and briſkly, it will no doubt have a leſs diuretic effect: But I apprehend that in moſt caſes in which it is recomended, the conſumptive eſpecially, it is intended that it ſhauld tend moſtly this way: if it fails of it, and does not prove purgative in ſome degree, it occaſions many inconveniencies, as fullneſs and ſwelling of the ſtomach, want of appetite, anxiety of the præcordia, difficult breathing, flatulency, lowneſs of ſpirits, heavineſs, drowſineſs, *&c.*

On the contrary, when it paſſes freely, the ſpirits become light, free and tranquil: it invigorates when wine would depreſs, and remarkably quickens the appetite, as is well known to moſt Whey-drinkers, who ſeldom fail to have a keen appetite for breakfaſt, after duly paſſing their Whey.—I have frequently remarked that in hypochondriac conſtitutions generally inclined to habitual coſtiveneſs, it puſhed very briſkly by urine, rather I ſuſpected, too much, and in this caſe it generally occaſions coſtiveneſs. Lenient purgatives to determine it the other way, are the remedy: It is uſuully more diuretic to lean habits, than to ſuch as incline to corpulency.

If on trial it is found that it does not paſs freely, the aſſiſtance of diuretic medicines will be neceſſary; the neutral ſalts ſeem proper to anſwer this end, and are found ſo from experience; eſpecially ſuch of them as at the ſame time looſen the belly. *Glauber*'s ſalt, *Sal polychreſt*, and the *Sal diureticus* are among theſe: the latter eſpecially I have known very beneficial, in cauſing it to ſit very light and paſs quickly. Riding out on horſeback generally determines it to the kidneys.

Tho' the diuretic effect of Whey is the moſt neceſſary and beneficial, it is alſo neceſſary that it ſhould operate by ſtool: But from what experience I have had, it ſeems to appear, that there are not many conſtitutions it will have this effect on without aſſiſtance: on the contrary, I have known moſt perſons rendered coſtive by it.

When I began to have ſome experience of its effects on myſelf and others, I was ſurprized to find an opinion generally prevail, that purging was its moſt uſeful and proper effect, and that little benefit was to be expected, if it did not operate briſkly this way, either naturally or by art. The opinion of an old Practitioner here ſeems to have been the occaſion of it at firſt, near 40 years ago. His rule was, to ſwill down as large doſes as the ſtomach would admit, and to take a good quantity of that draſtic purgative, Buckthorn ſyrup with it; by which means it may be believed, it would not be lazy in making it's way. Five, ten, fifteen motions a day were common. On inquiry I found that numbers of hectic perſons had been hurried off by this ſcheme: the caſe is now alter'd indeed; perhaps I may have contributed to bring this about by declaiming on all occaſions againſt it. Much leſs provocation than this will ſuffice to bring on that dangerous ſymptom, a *diarrhæa colliquativa*, to which all hectics are naturally prone, and whereof ſeveral inſtances have been known. And not only this, but many other miſchiefs follow: I have repeatedly experienced, that appetite and digeſtion weak enough before, became more impaired; even the Whey itſelf would not digeſt: the chylopoietic organs were quite relaxed and enfeebled, and great general debility and tremors were brought on, flatulency in the bowels, lowneſs of ſpirits, *&c.* On the contrary, one, two, at moſt three eaſy motions a day (eſpecially if three pints had procured them, without purgative medicines) had all the contrary effects: appetite and digeſtion improved, greater freedom of ſpirits, cheerfulneſs, lightneſs, *&c.*

But if it fails to have this effect, means muſt be uſed to aſſiſt it. Many have ſuffered meerly from not attending to this; from drinking on for ſeveral days together and quite coſtive all the time, obſtructions of the abdominal *Viſcera* are a natural conſequence: I knew a Jaundice brought on by it.

Glauber's Salt I have experienced a good medicine in general, to one, two or three drams every morning. The diuretic ſalt in an increaſed doſe promiſes to be a very good medicine here; beſides it will greatly improve the attenuating and reſolving properties of the Whey, and render it more active and penetrating.

Manna, Rhubarb, Sal polychreſt, Rufi pills, *&c.* may be proper, according to the diſeaſe and conſtitution: But the beſt method ſeems to be to turn the Goats into a Paſture where purgative herbs abound, or gathering them for the Goats: Thoſe that are indigenous here are chiefly *Linum catharticum*, *Ebulus et Sambucus:* The firſt they eat readily and is pretty common; it's too great ſharpneſs is ſoftened in the Whey. It is frequently the cauſe of it's purging more than uſual: The other two they will ſometimes crop, but moderately. The *Soldanella* grows on *Dundrum* ſhore. *Bennet* in his *Theatrum Tabidorum* propoſes encouraging Sweat in conſumptions, particularly that kind of Tabes which he treats of, under certain reſtrictions. I have not experienced whether his ſcheme is a good one in any caſe but my own, which was a Phthiſis from weak, lax lungs, attended with a moſt copious diſcharge of viſcid phlegm, often reſembling genuine pus. I was hectic ſome years, and drank whey moſt of the ſummer; during the whole time I had moſt extraordinary night ſweats, not leſs often than two, or three, or four pounds a night: next morning I drank my whey and inſtead of being weak and feeble, was light and eaſy, my ſpittle came freely and was better concocted than uſual, juſt as *Bennet* repreſents: But what was moſt remarkable, it kept off the Hæmoptoe, which ſurely came if my ſweat was interrupted.

In ſuch caſes, and perhaps ſome others, Whey may be uſed to good purpoſe as a ſudorific; it muſt weaken leſs than any other.

SECTION IV.

Of the Uſe of the Non-naturals during a Whey Courſe.

MOST perſons who have gone thro' this courſe once or twice have experienced, that this is by no means to be neglected, but a proper choice of air, good chambers, meat, drink and exerciſe is diligently to be attended to; elſe ſo far from reaping any advantage from it, their diſorders may be aggravated, and others, ſometimes fatal ones, be brought on. The judicious *Boerhaave*, I have been told, in preſcribing to the conſumptive, never omitted mentioning a proper diet, and that they ſhould take particular care to lie in an upper chamber. Such a rule is perhaps in no caſe more neceſſary than here, as I have often ſeen confirmed by experience. The repeated catching of colds ſo incident and fatal to conſumptive perſons, in this our moſt changeable climate, and the night tickling coughs, have to my knowledge been often highly aggravated by lying on ground floors.

The principal rule as to meat is, to avoid all ſuch kinds as are any wiſe flatulent, viſcid or acrid, to chuſe ſuch as are light and rather of an antacid nature, and moſt kinds of white fleſh meats; and thoſe who are not in a very low ſtate may uſe moderately the lighter flat fiſh, ſoal and flounder; of the teſtaceous tribe, river and ſea crabs, eſpecially the claws of the latter.

All ſorts of garden ſtuff, a few excepted, are well known to diſagree with whey drinkers. The never failing conſequence of eating any of the green ſort eſpecially, is, to generate ſuch a degree of ſour flatulency as diſtends the ſtomach and bowels and moſt effectually retards the paſſage of the whey either by urine or ſtool.

I have tryed experiments with them on myſelf and found this the conſequence: beſides, I have been taken with ſevere gripings and dyſenteric ſtools. Freſh baked bread, has in a leſs degree the like effects. Celeri, Aſparagus and Artichokes I have found pretty inoffenſive. The rheumatic, gouty and ſcorbutic may uſe the warm alcaleſcent ſorts to advantage, hot Sallads, Onion, Leek, Radiſh, Garlick, and ſuch like. Ripe fruit and acids are religiouſly to be avoided. As for drink, ſpecial care ought to be taken to chuſe right good water: This, with or without wine, ſeems the only proper drink with meat, as all malt liquors, cyder and punch are very improper. I know of no general rule as to the ſort of wine to be choſen; Claret in general is moſt agreeable. Particular caſes admit of various other kinds, of which the attending Phyſician muſt judge. It's not to be expected that too free a uſe of Claret will be excluded from the ſociety of Whey-drinking Gentlemen, more than other ſocieties: too many inſtances occur of Gentlemen injuring themſelves ſenſibly, ſometimes drinking more Claret after dinner, than Whey before it, and ſometimes a large quantity of each. They tell a ſtory of a Gentleman, of a pretty full habit, who after leading this ſort of life for ſome weeks, taking ſix or ſeven quarts of Whey before and two or three of Claret after a hearty dinner, fell down apoplectic on riſing from table after one of theſe doſes. A more effectual ſcheme to create a high Plethora, can ſcarce be deviſed.

Whey-drinkers ſoon learn the neceſſity of Exerciſe; for without this it lies heavy on the ſtomach and occaſions remarkable heavineſs, indolence, drowſineſs, and does not paſs freely. Walking about before breakfaſt, and riding after it is the uſual method, in a whey-courſe, as well as during either medicinal courſes, amuſements and having the mind quite *degagé*, is a material circumſtance: the patients are generally very careful in promoting innocent amuſements, and perhaps find as ſolid pleaſure from thoſe rural ones as from the gay ones of the town.

I have frequently known the cold bath uſed with a whey-courſe, for ſeminal weakneſſes moſtly, but with indifferent ſucceſs, as it very often occaſioned a giddineſs. I much ſuſpect it is not a ſafe method to bath and drink whey at the ſame time, and never recommended it.

As to the quantity to be drank daily, different caſes will require different doſes. In general, the quantity preſcribed by *Dioſcorides*, *Aegineta* and others of the Ancients, anſwer beſt, being from one to three or four pints. Many ſtomachs will not bear above one, and even that prove emetic, till they are by degrees habituated to it. Large quantities ſeem to do harm in moſt caſes. It ought in general to be drank near blood-warm.

The time of beginning to drink it varies according to the earlineſs or lateneſs of the ſeaſon. About the the middle of *May* N. S. is the uſual time of beginning it: about the 10th of *July* the Milk becomes thick of courſe, the Whey can't be got clear, and contracts ſuch a rank taſte, that few are able to uſe it longer.

SECTION V.

Diſeaſes which drinking GOAT'*s* WHEY *may be proper for.*

DISEASES of the lungs, coughs and conſumptions, whether under the appellation of phthiſis, tabes or atrophia, are thoſe to which, according to the commonly received opinions, whey drinking hath not without reaſon been chiefly appropriated: not but there are many others which repeated experience has vouched it good for.

If it is conſider'd that Whey is a half animalized liquor, (tho' ſtill partaking of the vegetable nature) and highly nouriſhing, as well as balſamic and demulcent, one can ſcarce withold his aſſent that it promiſes being ſpecifically proper in all ſorts of decays, particularly where the lungs, the *officina ſanguificationis*, are injured and incapable of duly perfecting the chyle.

What liquor can we ſuppoſe more proper to repair the loſt nutritive quality of the blood, ſpecifically to correct the highly ſeptic acrimony of abſorbed purulent ſanies and to repair the waſted ſubſtance of the lungs? Whether a *Phthiſis* is from a preceding inflammation, ending in ſuppuration, not improperly denominated an acute one: whether from little abſceſſes of the tracheal glands, or from a gleetyneſs of the glands, or the *Phthiſis* only threatens by an *Hæmoptoe* appearing, either of florid, ſalt, arterial blood or dark coloured, clotted inſipid blood: In ſhort, wether the *Phthiſis* is acute or chronical, from a prediſpoſition in the habit, or brought on by hard living or external accidents, long experience has now taught us that Whey-drinking is the ſheet anchor, but eſpecially in the acute or galloping ſort. I have known caſes indeed, where experience gave the preference to Aſſe's milk with *Pouhon* or *Briſtol* water, in chronical *Phthiſes*. In moſt of ſuch as I have been concerned in, I have adviſed that courſe after the Whey courſe was over, to excellent purpoſe. The acute kind won't eaſily admit it, eſpecially the uſe of the *Spa* Water.

However in all kinds, where there is a diſpoſition to ſpit blood, the firſt days of Whey-drinking are apt to renew the Hæmmorhage, which previous bleeding ought to guard againſt, if the Patient's ſtrength will poſſibly bear it. It always affected myſelf in this manner.

As to decays in general, it muſt be owned, that where there is an hereditary diſpoſition, or even a perſonal tendency from infancy, they ſeem to be beyond the reach of art, unleſs change of climate may make an impreſſion. In ſuch caſes I have known the Whey drinking prolong life, but not cure: but where winter colds, pleuritic diſorders, errors in the non-naturals or external injuries, have carried the patient even as far as a hectic, ſuch often return from it reſtored to perfect health and ſtrength: I have known many ſuch caſes.

But in every ſuppoſable caſe, it's uſe is very precarious, nay injurious, after the *Diarhœa colliquativa* has once appeared. I have always obſerved that it had no other effect then, but by increaſing this ſymptom to ſhorten life. Many ſuch have been hurried off, without being able to travel home. I knew and was frequently concerned in, a good family, hereditarily ſubject to a ſort of Tabes, ſuch as we are told is endemial in ſeveral fenny counties in *England*, but not common here, who were all plentifully and carefully ſupplied with Goat's Whey every year, almoſt from the cradle; yet 7 or 8 Children died of it about the age of puberty: only one was ſaved, whoſe health I had the direction of for many years, and is now a man. He had a real *Gonorhœa non-virulenta* or natural gleet. (never I'm aſſured having lain with a woman,) debility in his back and was hectic, ſo that the diſorder might perhaps be juſtly called a *Tabes Dorſalis.* He took Rhubarb and Styptic tincture with the Whey, and after it, drank Aſſe's or Mare's milk with Lime-water the reſt of the year.

In hectics from ulcers after wounds or other external injuries I have known Whey to effect very ſpeedy recoveries. If ulcers in any of the abdominal Viſcera are the cauſe of a *Phthiſis*, there is no doubt of its being proper. I had occaſion to ſee very good effects from it in a caſe of very high hectic from an ulcer ſomewhere about the head of the *inteſtinum rectum*, which diſcharged itſelf into it, and yet could not I apprehend be properly termed a *Fiſtula*.

I have not had an opportunity of experiencing it's effects in ulcers of the kidneys or bladder.

There are every ſeaſon caſes of ſtubborn gleets in perſons whoſe conſtitutions are ſhatter'd with venereal diſorders and mercurial courſes, and often attended with hectical ſymptoms who reſort hither to be refitted, frequently with very good ſucceſs, where they will ſubmit to the rules of temperance and ſobriety, but it may eaſily be conceived that many ſuch perſons can't bring themſelves to ſubmit to theſe conditions.

In the diabetes, Dr. *Mead's Serum Aluminoſum* be admitted a good medicine; it might perhaps be very advantageouſly made of Goat's milk.

Whether it would prove a remedy in that ſort of Scurvy, which *Lynd* calls the true Scurvy, I know not, but have had frequent opportunities of ſeeing it's effects on theſe eruptions on the ſkin commonly called ſcurvies (in which caſe alſo the ancients particularly mention it's uſe) where it ſeldom fails of being very ſerviceable, eſpecially if the antiſcorbutic Juices are uſed at the ſame time in ſuch quantity as to keep the belly ſoluble.

I have a patient who has drank it in this manner theſe many years, to ſtave off an atrophy, apparently from a ſcorbutic cauſe with great ſucceſs. Several perſons who have drank it aſſert it's great efficacy in fixing the irregular gout, and that it is of equal efficacy with the *Bath* waters in that caſe. There may be many other caſes in which it may be proper, when diſeaſes are actually come on or well advanced, but *venientie occurrit morbo* ſeems in no caſe more applicable. Diætetic regimen is no doubt among the chief inſtruments of preſervation from diſeaſes. Whey is a diæletic medicine, and though it will often cure in a very agreeable manner when the diſeaſe is far advanced, yet it will probably operate with much greater certainly, if uſed in a preſervative way, to rectify the natural or acquired bad diſpoſition of the blood and juices. It does not require an extraordinary degree of ſagacity to foreſee a tendency to conſumptions. The make of the thorax, the complexion, too great ſprightlineſs, the hereditary diſpoſition, but above all, young perſons advancing too faſt in their height; theſe ſhould give the alarm and indicate, that unleſs the blood is kept pure, ſweet, free from acrimony and a *plethora* avoided, an *Hæmoptoe* will probably come on, eſpecially in females about fourteen. Goat's whey in ſuch circumſtances, uſed every year, has not perhaps it's equal: This I have ſeen frequently confirmed by experience. I have a patient juſt now *June* 1757, drinking it, a young Lady of a thin habit, who had ſeveral attacks laſt winter of a tickling cough and pungent pain in the ſide, which came and went, but in *May* ſhe had a return, attended with hectic rigors, heats and night ſweats, of all which ſhe is perfectly relieved by three weeks drinking. It had beſides an effect on her, not uncommon, reſtoring the ſuppreſſed Menſes, as hath been frequenly obſerved in Hectics, no doubt by it's analeptic, reſtorative virtue, an effect which perhaps ſcarce any other medicine will produce, Aſſe's milk alone excepted, no not even the moſt ſubtile of the Chalybeat waters, which tho' blended with Milk, generally increaſe the heat and tenſion of the pulſe, as I clearly ſaw in a very delicate caſe laſt winter.

I have indeed known the Menſes reſtored by it in conſumptions, after a long ſuppreſſion, and yet the diſorder prove fatal, but more tedious.

SECTION VI.

Of the Inconveniencies of Whey-drinking.

THAT Goat's Whey is a pleaſant and moſt uſeful medicine, cannot be denied, yet like all others it has it's inconveniencies. Many of theſe, it muſt be owned, proceed from improper management; for it's very name, to the unexperienced, ſeems to ſpeak it a ſimple familiar medicine that may be uſed in any caſe and without being confined to any rules: The contrary whereof has been experienced by many to their coſt, nay is ever year experienced: tho' it is drank regularly, I have obſerved it injurious to three ſorts of conſtitutions or habits. 1. To ſuch as had weak nerves. 2. To ſuch as had a thin pale watery blood, or were leucophlegmatic. 3. To the ſanguine, corpulent and plethoric. 4. To many who have original weak nerves, are habitually affected with tremors, debility, ſpaſms and cramps, colics, hyſterics, nervous head-achs, giddyneſs, *&c.* What experience I have had declares, that Whey-drinking has diſagreed with ſuch, by renewing or increaſing thoſe complaints. I have ſeen where theſe were complicated with chronical *Phthiſes*, that whilſt the ſymptoms of the *Phthiſis* decreaſed, during the Whey-courſe, great complaints attended of low-ſpirits, chillyneſs, indolence, drowſineſs, *&c.* A very common effect of Goat's whey is, to occaſion drowſineſs; eſpecially in the morning. Lying a bed after the firſt draught increaſes it very much; for it will have a real apparent narcotic effect. Perhaps it's paſſing quickly into the blood and increaſing the fulneſs of the blood veſſels, eſpecially of the brain, may be the cauſe, according to the uſual theory of accounting for the effects of *Opium.*

I firſt obſerved this effect on myſelf, who have feeble nerves, but afterwards I found many others affected in the like manner, thoſe particularly of weak fibres and delicate habits. I don't know from experience that this has any bad conſequences: on the contrary have often obſerved that perſons thus affected by it, gained ground daily in their health. If the tone of the ſolid nervous ſyſtem were really and actually impaired, it would be eaſily diſcovered afterwards.

This however is meant of hectical patients; for I have known it have laſting injurious effects on ſubjects of weak nerves who were not conſumptive.

I have met with ſome caſes of perſons ſent to uſe it, who were habitually of weak, lax ſtomachs,

machs, that daily generated large quantities of viſcid, phlegmatic crudities. Whey remarkably increaſed the quantity of theſe, brought on inflations of the ſtomach, head-achs, lowneſs of ſpirits, feebleneſs, appetite quite loſt, *&c.* I ordered them immediately to quit it. One Gentleman by my advice went to *Bath*, and there found the wiſh'd for remedy. Theſe perhaps may be claſſed under the ſecond Head.

It is not however, I apprehend, an univerſal rule, that it diſagrees with all weak, watery blooded ſubjects; if they are conſumptive, quite otherwiſe; but if not, it frequently has bad effects. Indeed I imagine it abſurd to ſend ſuch to it. If they want a reſtorative, let them ſtay at home and drink Aſſe's or Mare's milk with *Spa* water; an advice I have given with ſucceſs.

3. As to ſanguine, corpulent, and plethoric perſons, it may be alledged that ſuch ſeldom or never try it: the contrary however has happened within my knowledge. Such frequently come to it, chiefly for ſcorbutic ailments, or amuſement: and if they would practiſe due evacuations and temperance, might reap benefit: but this is not always the caſe, as appears from the tragical hiſtory I have from good authority related above, of the unhappy Claret-prone gentleman who died apoplectic on ſwilling down large quantities both of Whey and Claret on the ſame day.

I have ſeen caſes of plethoric perſons, Whey drinkers, who have been in great danger of overfulneſs, till relieved by plentiful evacuations, which if neglected, fatal conſequences followed. An elderly Gentleman had long been affected with a vertigo and dimneſs of ſight: unhappily he was ſent to drink whey. In a morning he was ſuddenly ſeized with his old complaints and a paralytic weakneſs of one ſide. I accidentally was preſent, but he refuſed my offered aſſiſtance, would not loſe blood, in a few hours he was ſeized with ſhocking epileptic fits, which in one night gave effectual relief from all worldly cares. I diſſected his brain and found amongſt other things, a Hydadid, lying over the commiſſure of the optic nerve, apparently the cauſe of his old dimneſs of ſight. I gave it as my opinion, that the Whey, by creating a plethora and filling this and other ſmall hydadid in the brain, was the cauſe of his ſudden fate. It ſeems to me a very proper rule, that no perſon affected, or even threatned with Apoplexy, Epilepſy, Vertigo, Palſy or any of their ſubdenominations, ought to make free with Goat's whey: That this is not generally known is evident, from ſeveral ſuch being ſent to it by phyſicians of character, as I have known, and the above is an inſtance to this purpoſe. Theſe diſeaſes generally are owing to cauſes in the brain, which are always aggravated or brought into action by fulneſs of the blood veſſels. Even tho' they ſhould be complicated with conſumptive hectic, I much doubt whether Whey-drinking be ſafe. *Briſtol* water ſeems more eligible.

DOWNPATRICK, *July* 1757.

ADVERTISEMENT.

THE Compiler of the foregoing Tracts begs leave to inform his Subſcribers, that he has, for ſeveral years paſt made collections of materials towards a Specimen of a natural Hiſtory of the County of Dublin *at the requeſt of the late* Phyſico-hiſtorical Society; *but as he is well aſſured that divers particulars with regard to various Earths, Clays, Marls, Sands, Spars, Cryſtals, Ores, and other Minerals muſt have eſcaped his notice; if any public ſpirited perſons who may be willing to encourage the Work will furniſh him with any notable Specimen or Specimens of the above mentioned or other Foſſils found in this County, he will endeavour to do due honour to ſuch communication.*